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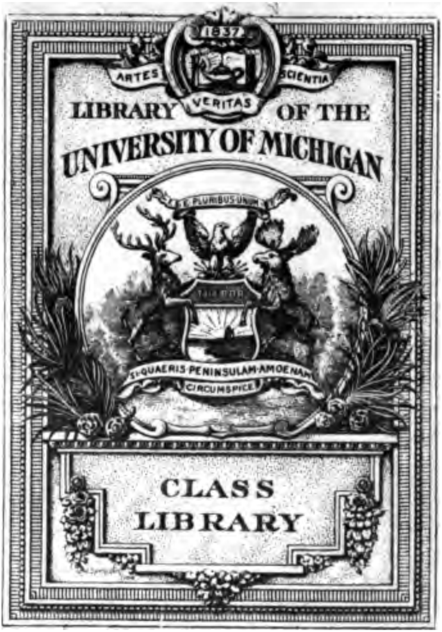

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OFFICE OF THE ADJUTANT GENERAL

PROVISIONAL
Drill and Service Regulations for Field Artillery
(6-inch Howitzer)

1917

▽

VOLUME III
Part IX

WASHINGTON
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1917

WAR DEPARTMENT
Document No. 569.
Office of The Adjutant General.

WAR DEPARTMENT,
WASHINGTON, *April 19, 1917.*

The following system of Provisional Drill and Service Regulations for Field Artillery (6-inch howitzer), 1917, is approved and herewith published for the information and guidance of the Army of the United States.

Battery, battalion, and regimental commanders whose commands include 6-inch howitzer matériel will submit to The Adjutant General of the Army any suggestions relative to the Provisional Drill and Service Regulations which they think will add to their value.

BY ORDER OF THE SECRETARY OF WAR:

H. L. SCOTT,
Major General, Chief of Staff.

OFFICIAL:
H. P. McCAIN,
The Adjutant General.

C7153

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PART IX.

FIRING INSTRUCTION.

CHAPTER I.

OBJECT AND SEQUENCE OF THE INSTRUCTION.

833. The objects of this instruction are:

1. To train the personnel in the mechanism of the methods of fire so that, at the word of command, fire of the desired nature may be delivered with certainty and celerity. **(Fire discipline.)**

2. To train officers and their assistants so that they may utilize the weapons at their disposal to the best advantage. **(Conduct of fire.)**

834. A progressive order of instruction will be followed in each case.

Training in the elementary duties of the two kinds should be undertaken separately at first. Drill in the mechanism of fire is the essential feature of instruction of the first kind; practice in determining firing data and in adjusting fire under various assumed conditions is the essential feature of instruction of the second kind.

835. All officers and men should receive training in fire discipline. It begins with the instruction of the **cannoneer,** passes to that of the **gun squad,** then to that of the **firing battery,** and then to that of the higher units.

The cannoneer must be taught to perform quickly and correctly the individual duties required of him in the service of the piece. He must acquire such a thorough knowledge of these duties and such a well-grounded habit of performing them properly that the service of the piece will not be affected by the excitement of action.

The gun squad must be trained as a unit, so that its individual members work together smoothly, quietly, and effectively in serving the piece.

The instruction of the firing battery and of the higher units should secure the harmonious working of the organization in delivering fire.

836. Training in conduct of fire begins with the instruction of individual officers and their assistants and then passes to that of appropriate combinations.

The individual must be taught the care and the accurate and rapid use of the instruments supplied for observation and communication and must learn to put into practice the principles underlying observation of fire and its adjustment to secure effect.

The combined personnel must be trained so that individuals work together smoothly and effectually in obtaining accurate and useful information and in its correct application and transmission.

837. Not until instruction in fire discipline and in conduct of fire have each sufficiently progressed should they be combined. The training should be carried on, first in the park or on the drill ground, and then on terrain of every available description; targets representing as nearly as possible those to be met in service should be attacked, first by simulated fire, then with subcaliber and service ammunition. The commander is thus enabled, without confusion or delay, to turn the fire of his unit from point to point and to concentrate or distribute this fire in such manner as may be most desirable.

CHAPTER II.

THE CANNONEERS.

SECTION I.—METHOD OF INSTRUCTION.

838. In view of the great importance of instruction of this character, it is begun as soon as the recruits join the battery and is continued in addition to other instruction until the cannoneers are thoroughly skilled in their individual duties. It will often be found advantageous to give the older cannoneers instruction of this kind from time to time.

839. Care must be taken to impress upon the recruits the importance of the instruction of cannoneers and to maintain their interest. The time spent in thoroughly training the individual cannoneer in the operation of the matériel will result in increased rapidity and accuracy of the gun squad as a whole.

840. The instruction of cannoneers and of gun squads will be under the immediate supervision of one or more battery officers selected for this work.

841. The permanent gunners and men skilled in the duties of Nos. 3 and 4 can be used to advantage in the instruction of the recruits. By assigning particular details of instruction to the older men and by causing the recruits to pass from one to the other of the instructors, the instruction is expedited and uniformity is secured. The officer in charge must be careful that the instructors are accurate in their explanations and that they insist upon exact performance of the various duties.

842. During instructions in the individual duties in the service of the piece special stress must be laid on the necessity for accuracy. The recruits should be made to understand t speed is purely a matter of practice, but that accuracy can c be obtained by forming the habit of exactness from the be ning. Rapidity is increased by insisting that each indivi perform his duties in regular sequence.

843. To provide variety and so to maintain interest, instruc in the duties of the gun squad (**929–943**) may be begun afte few days of instruction in the duties of the cannoneers; but last-mentioned instruction must not be curtailed. The kee of records as to the time required by each cannoneer to perf the various duties and of the errors made not only stimul interest but furnishes an intelligent basis upon which to se men for permanent assignment.

SECTION II.—INSTRUCTION IN MATÉRIEL.

844. The instruction begins with the first drills of the c noneers, and is carried on during the intervals of more advan work. It is usually conducted in the park and should be p tical in its nature, involving a careful and painstaking desc tion, supplemented by actual demonstration of the method operation of the particular element of the matériel being scribed. It is continued until there is acquired an intim knowledge of the matériel in use in the battery, embracing s subjects as the following:

1. Nomenclature of the principal parts of the piece, caiss and limbers and their respective equipment.
2. Purpose and operation of the different parts of the howit and carriages; for example, the application of the brakes.
3. Description and use of the sights, their attachment their manipulation.
4. Kinds of projectiles and the special uses of each.

5. Names and objects of the parts of fuses and fuse-setters and their mode of operation.

6. Disassembling and assembling those parts of the matériel which frequently require cleaning and repair.

7. Transferring the sight and sight shank between their traveling and firing positions.

8. Preparation of the powder charge.

9. Names of tools and accessories; where they are carried; how they are used.

SECTION III.—DUTIES IN DETAIL OF THE GUNNER.

845. The duties of the gunner in the service of the piece are:

1. To set the deflection.
2. To apply the deflection difference, if any.
3. To set off the site.
4. To set the range on the sight shank.
5. To level the cross level bubble.
6. To give the direction to the piece.
7. To give the elevation to the piece.
8. To call ready when the piece is accurately laid.
9. To move his head out of the way of the sight before the piece is fired.
10. To give the command to fire the piece.
11. To measure a deflection.
12. To measure a site.

The Deflection.

846. The deflection is the horizontal angle between the line of sight and the axis of the bore. It is measured or set off by the sight. There are two kinds of sights, the **panoramic sight** and the **peep sight**. The panoramic sight is habitually used except in emergencies.

847. The panoramic sight is so constructed that any ho zontal angle can be laid off by it and by changing its setti the gunner can look in any horizontal direction. The panoram sight has two scales: That on the body of the instrument co sists of 64 equal divisions numbered alternately on the eve divisions from 0 to 62; thus, 0, 2, 4, 6, etc., 62, but which a read 0, 200, 400, 600, etc., 6,200. This is called the **limb** of t instrument. The smaller scale on the left side of the body the instrument consists of 100 equal divisions and is called the **micrometer.** A complete turn of the micrometer changes the reading of the limb by one division. The complete circumference is, by this arrangement, divided into 6,400 equal parts, and the **least reading** is one of these parts, called a **mil.** A deflection of 1 mil corresponds to a deviation at the objective of one one-thousandth of the range. Hence a difference of 1 mil in deflection is equivalent to 1 yard in direction at 1,000 yards from the howitzer, to 1½ yards at 1,500 yards, and so on.

When the panoramic sight is set at zero the vertical plane through the line of sight is parallel to the axis of the bore.

848. To set off a deflection on the panoramic sight: The gunner turns the rotating head of the instrument until the number of hundreds of the setting is shown by the index of the limb, and the number of tens and units, if any, by the index of the micrometer.

If, in setting the deflection, the rotating head of the instrument has to be moved through a small angle only, the slow-motion screw is used. But if the reading given requires a large, angular movement, the slow-motion mechanism is ungeared and the rotating head is turned around to the approximate position by hand. The slow-motion mechanism is then thrown in gear and used to set off the exact setting.

849. The gunner is practiced in setting deflections on the panoramic sight by command. Thus, for example: **Deflection, 1,640.**

The gunner brings the index of the limb between the divisions marked 16 and 17 of the limb, then, keeping the index between these divisions, turns the micrometer until its index reads 40. The instructor verifies the setting.

850. The graduations on the deflection scale of the peep sight correspond to those on the panoramic sight, the unit of the scale being 1 mil. When set at 0 (6,400) the vertical plane through the line of sight is parallel to the axis of the bore. Toward the left the readings increase, the maximum reading being 45 mils; toward the right the readings decrease, the minimum reading being 6,355 mils.

To set off a deflection on the peep sight: The gunner turns the peep-sight screwhead with his left hand until the index is opposite the desired graduation.

He is practiced in setting off deflections as before (849).

The use of the peep sight is of rare occurence.

851. To throw the projectile to the left, increase the deflection. To throw the projectile to the right, diminish the deflection. During the firing the captain changes the direction of fire by commanding: **Right (Left) (so much).** The command **Right (Left)** indicates the direction in which the captain wishes to throw the projectile.

The gunner is practiced in setting off a new deflection. Thus, the reading being 1,620, **Left 20**; the gunner at once sets 1,640.

The Deflection Difference.

852. The training of the gunner in applying the deflection difference (982 et seq.) is begun when he is expert in setting off the deflection.

The Site.

853. The site is the vertical angle between a horizontal p through the howitzer and the line from the howitzer to objective. The site is measured in mils, and a difference of o mil of site corresponds to a difference in level between t howitzer and the objective of one one-thousandth of the ran The site is set off on the elevation level. The elevation level attached to the left side of the sight shank and is so constructe that vertical angles within certain limits can be laid off on i The elevation level has two scales. The scale on the body o the instrument, known as the level scale, is graduated in divisions of 100 mils each, marked 1, 2, 3, 4, and 5, which are rea 100, 200, 300, etc., mils. The second scale is a beveled mounted on the level screw, called the **level micrometer** and is divided into 100 equal parts. A complete turn of th micrometer scale changes the reading of the level scale by on division. The least reading of the micrometer is therefor on mil. The graduation 3 (300) on the level scale corresponds t targets at the same level as the piece; below 300 correspond to targets below the level of the piece; above 300 to targets abov the level of the piece.

854. To set off a site: The gunner turns the elevation leve screw so that the number of hundreds of the setting is show by the index of the level scale and the number of tens and unit if any, by the micrometer scale.

855. The gunner is practiced in this duty as follows: Th sight shank being in or out of its socket, the instructor commands, for example: **Site 315.**

The gunner turns the level screw until the index of the leve scale is between the graduation marked 3 and that marked and the index of the micrometer reads 15. The instructor verifies the setting.

The Range.

856. The range is the distance in yards from the piece to the target.

857. The sight shank has three range scales graduated in yards to correspond to the ranges of the **three zones.** These scales are:

First zone, 0 to 2,100 yards.
Second zone, 0 to 3,650 yards.
Third zone, 0 to 6,700 yards.

The least reading of the scales is 50 yards, but they may be readily set by eye to 25 yards.

If no zone is announced, the gunner sets his range in **zone 3.**

A zone having been announced, the scale for that zone is used in all subsequent settings until a new zone is announced.

To set off a range on the sight shank: The gunner turns the **zone shutter** until the **window** of the shutter bearing the number of the **zone** ordered fully uncovers the index of a range scale, the range scale thus uncovered is the range scale of the zone marked on this window of the shutter. He then moves the sight shank up or down in its socket until the desired range graduation is opposite the range index exposed by the shutter window.

He is careful to lower his head so as to look squarely at the range scale and its index.

The sight shank is moved up or down by means of a scroll gear. If a considerable movement of the shank is necessary, this mechanism is ungeared by releasing the scroll-gear lock and drawing outward the scroll-gear handle with the left hand; the shank is then raised or lowered with the right hand until the desired graduation is near the index. The mechanism is then thrown in gear, locked, and the scroll gear utilized to set the scale at the exact setting desired.

858. The gunner is practiced in setting the sight for range, thus: The sight shank being in its socket and the gunner seated on his trail seat, the instructor commands, for example: 4[illegible], or 1, **Zone two (one)**; 2, **3000 (1500)**. The gunner sets the sight as just described and the instructor verifies the setting.

The Cross Level.

859. **To center the bubble of the cross level:** The gunner, with his left hand, turns the level screw on the sight bracket until the bubble is centered.

The centering of this bubble is necessary to avoid errors in the direction of the piece due to any difference in level of the howitzer wheels.

It is important that it become habitual with the gunner to turn the cross-level screw clockwise to throw the bubble to the right, and vice versa.

The Direction.

860. **To give the direction to the piece:** The gunner traverses the piece on the carriage until the vertical cross hair of his panoramic sight is on the target or the aiming point. He habitually operates the traversing gear with his left hand. When he finds that he can not traverse the piece sufficiently to bring the vertical cross hair on the aiming point or target, he commands: **Muzzle right (left)** (922). Immediately upon giving this command the gunner brings his piece back to the center of the traverse.

861. The gunner is practiced in the manipulation of the traversing gear and in bringing the vertical cross hair accurately on the target or aiming point. It is important that it become habitual with the gunner to turn the traversing handwheel in a clockwise direction to throw the muzzle of the piece

to the left, and vice versa. The gunner must also form the habit of bringing the piece to the center of traverse whenever it is necessary to shift the trail.

862. When the gunner gives the direction to the howitzer by sighting directly at the target, the method is called direct laying; when he gives the direction to the howitzer by sighting on an aiming point, the method is called indirect laying.

The signal that direct laying is to be used, is the command: **Target (so and so).**

The signal that indirect laying is to be used, is the command: **Aiming point (so and so).**

The Elevation.

863. To give the elevation to the piece: The howitzer is given its proper elevation as follows:

In direct laying the gunner gives the piece its elevation by setting off the range accurately on the range scale of the sight shank (857) and operating the elevating mechanism until the horizontal cross hair of the panoramic sight is accurately on the bottom of the target.

In indirect laying the gunner sets off the site accurately on the elevation level (854); sets off the range accurately on the range shank (857) and operates the elevating mechanism until the bubble of the elevation level is centered.

The gunner is practiced in the manipulation of the elevating mechanism. It is important that he form the habit of turning the handle in a clockwise direction to increase the elevation and therefore the range and vice versa.

864. The gunner is practiced in the duty of laying for both direction and range as follows:

The gunner, being seated on his trail seat, at the piece unlimbered, the sights in their sockets, the bubble of the cross level centered, the piece at the center of its traverse, the **instructor** commands, for example:

Direct laying:

1. **Target, that gun.**
2. **Deflection, 10.**
3. **4,200 or zone 2 (1),** 4. **3,000 (1,500).**

1. At the indication of the target the gunner causes **the piece** to be pointed in the general direction.
2. Sets off the deflection ordered.
3. Sets off the zone and range ordered.
4. Centers the cross level bubble, if necessary.
5. Looks through the sight and operates the elevating and traversing mechanism, so as to bring the line of sight upon the bottom of the target.
6. Calls **ready** when the piece is laid.

The instructor verifies the sight settings, the centering of the bubble of the cross level, and sees that the piece is laid accurately upon the target.

Indirect laying:

1. **Aiming point, the chimney on that house.**
2. **Deflection, 2,455.**
3. **Site, 310.**
4. **4,100 or zone 2 (1),** 5. **3,100 (1,500).**

1. At the command for the deflection the gunner sets it off on the panoramic sight.
2. Causes the trail to be shifted, if necessary, until a side face of the sight is directed upon the aiming point.
3. Sets off the site ordered.
4. Sets off the zone and range ordered.
5. Centers the cross level bubble, if necessary.
6. Looks through the sight and operates the traversing mechanism until the vertical cross hair is on the aiming point.

7. Operates the elevating mechanism until the elevation level bubble is centered.

8. Calls ready when the piece is accurately laid.

The instructor verifies each scale setting, the centering of the cross level bubble and the elevation level bubble, and sees whether the vertical hair of the sight is accurately on the aiming point.

865. Whatever the method of laying, the gunner must always see that the piece is at the center of its traverse whenever it is necessary to shift the trail. This centering of the piece in its traverse and the accurate establishment of the general direction avoids frequent shifting of the trail and consequent loss of time which would otherwise result.

The Ready.

866. The call **ready** by the gunner indicates to the chief of section that the piece is accurately laid and is ready to fire.

To Avoid Injury.

867. Unless the gunner is careful **to move his head out of the way of the sight** before the gun is fired, the shock of discharge may bring the sight against his eye with sufficient force to injure it.

The Command to Fire.

868. The gunner invariably gives or repeats the command **fire** in actual or simulated firing, so as to insure his piece being fired at the proper time.

To Measure a Deflection.

869. The gun being established in direction, by direct laying or otherwise, the deflection may be measured by turning the rotating head of the panoramic sight until the vertical cross hair is on the aiming point. The reading of the instrument is then the deflecton sought.

870. The gunner is practiced in measuring the deflection as follows: The gun being laid in direction on the objective, with zero deflection and the gunner on his trail seat, the instructor commands, for example:

1. **Aiming point, that clock tower.**
2. **MEASURE THE DEFLECTION.**

1. The gunner turns the rotating head of the panoramic sight until the vertical cross hair is on the designated aiming point.

2. He then reads and announces the deflection, thus: **Deflection, 490.**

The instructor verifies the reading and sees whether the sight is accurately directed upon the aiming point.

To Measure a Site.

871. The howitzer is first laid on the objective by the gunner who sets the sight shank at any convenient range, the deflection at zero, and brings both the cross hairs on the objective by traversing and elevating the piece. He then centers the elevation level bubble by turnng the elevation level screw. The reading of the elevation level scale is the site of the objective.

872. The gunner is practiced in the duty of measuring the site as follows:

The howitzer being laid on the target by means of the panoramic sight, the sight shank being set at any convenient range, 2,700 for example, the instructor commands:

1. MEASURE THE SITE.

1. The gunner centers the cross level bubble if necessary.
2. Centers the elevation level bubble.
3. Calls out the elevation level scale reading, thus: *Site, 330.*

The instructor verifies the centering of the bubble and the reading of the elevation level scale.

SECTION IV.—DUTIES IN DETAIL OF NO. 1.

873. The duties of No. 1 in the service of the piece are:

1. To set and release the brake.
2. To disengage the pawls.
3. To open the breech.
4. To close the breech.
5. To engage the pawls.
6. To fire the piece.

The Brake.

874. To set the brake: No. 1 runs around the right wheel to the front of the piece and operates the brake hand wheel until the brake shoes bear firmly against the tires. He is responsible that the brake is set at all times during firing.

875. To release the brake: No. 1 runs around the right wheel to the front of the piece and operates the brake hand wheel until the brake shoes are well away from the tires.

876. At the command **muzzle right or left** (922) No. 1 runs to the brake hand wheel and releases the brake. At the command **posts,** he sets the brake and resumes his post.

To Disengage the Pawls.

877. No. 1 presses the pawl handle to the front with his left hand and operates the quick-return mechanism with his right hand so as to depress the muzzle of the howitzer until th rockers are clear of the pawls. He then continues to depre the muzzle until the howitzer rests on the depression stops.

The Breech.

878. **To open the breech:** No 1 grasps the operating lever with his left hand and compresses the lever latch. He then draws the lever to the rear and right thus swinging the block to the right. The lever should be drawn sharply so as to give the extractor sufficient force to throw the cartridge case clear of the piece.

879. **To close the breech:** No. 1 places the middle of the palm of his open left hand against the operating lever, pushes the lever to the left and swings the block smartly to its seat.

To Engage the Pawls.

880. No. 1 pulls downward on the rear of the cradle with his left hand and operates the quick-return mechanism with his right hand until the pawls engage the rockers.

To Fire the Piece.

881. No. 1 grasps the firing lever with his left hand. It is important that he form the habit of firing with his left hand only. This makes it impossible for No. 1 to have any part of his body in the way of the howitzer during recoil.

882. When for the first shot the chief of section cautions **with the lanyard,** No. 1 attaches the lanyard to the firing mechanism and steps to the right rear clear of the wheel, holding the end of the lanyard in his left hand.

883. At the command **fire** of the gunner No. 1 pulls the firing handle toward his body, with his left hand, so as to release the firing pin.

In firing with the lanyard, No. 1 pulls on the lanyard until the firing pin is released. The lanyard is used only when the ground is such that the trail spade is not easily seated and then usually for the first shot only.

884. As soon as the piece is fired No. 1 disengages the pawls and opens the breech, swinging the block smartly so as to eject the cartridge case.

SECTION V.—DUTIES IN DETAIL OF NO. 2.

885. The duties of No. 2 in the service of the piece are:

1. To ram the projectile.
2. To receive the cartridge case.

To Ram the Projectile.

886. As soon as the projectile is at the breech No. 2 mounts the trail holding the rammer staff in both hands, rammer head to the front. Placing the rammer head against the base of the projectile, he starts the projectile sliding slowly forward and then forces it smartly into its seat in the bore. Before ramming, No. 2 causes the loading barrow to be moved, if necessary, so that the projectile is in prolongation of the bore. After ramming No. 2 replaces the rammer on the ground and takes his post.

To Receive the Empty Cartridge Case.

887. As soon as the piece is fired No. 2 springs to the breech, receives the empty cartridge case as it is ejected and throws it clear of the caisson or limber from which it was taken. The cases are stored when convenient.

SECTION VI.—DUTIES IN DETAIL OF No. 3.

888. The duties of No. 3 in the service of the piece are:

1. Assists at the loading barrow.
2. In time fire sets the fuse setter.
3. In time fire sets the fuse.
4. Assists No. 4.

The Loading Barrow.

889. No. 3 supports the front end of the loading barrow with both hands as the projectile is drawn from the chest.

In time fire when No. 3 has the fuse setter in his hands, he lays the fuse setter between the upper and lower compartments of the ammunition chest before assisting at the loading barrow and retakes the fuse setter as soon as the projectile is securely on the barrow.

The Fuse Setter.

890. The fuse setter is a device for setting time fuses so that the projectiles will burst in the air at such heights as may be desired. It has a separate range scale for each of the three zones, and a corrector scale and a movable range index. The range scales are graduated in yards with a least reading of 50 yards as follows:

Zone 1: 0 to 2,100 yards.
Zone 2: 0 to 3,500 yards.
Zone 3: 0 to 6,500 yards.

The fuse setter is so arranged that, when it is set for any particular range and properly applied to the fuse, the fuse will be so set that after the piece is fired the projectile will burst at about that range.

The corrector is graduated uniformly into divisions, numbered 0, 10, 20, etc., 120.

The fuse setter is so arranged that the setting of the fuse is modified by the setting of the corrector and the time of burning of the fuse and the point at which the burst occurs may be controlled without changing the range setting on the fuse setter.

891. Increasing the corrector shortens the time of burning of the fuse and hence raises the point of burst of the projectile; decreasing the corrector lengthens the time of burning of the fuse and hence lowers the point of burst of the projectile

The corrector scale thus affords the means of correcting an observed error in height of burst and adjusting the mean point of burst at the proper height.

892. To set the corrector: No. 3 turns the corrector worm knob with the right hand so as to bring the corrector reading ordered opposite the corrector index. It must become habitual with No. 3 to turn the corrector knob in a clockwise direction to decrease the reading and to turn the knob counterclockwise to increase the reading.

893. To set the range: No. 3 slides the range index to its position beside the range scale of the zone ordered and turns the range worm so as to bring the range reading ordered opposite the index. It must become habitual with No. 3 to turn the range worm clockwise to decrease the reading, and to turn it counterclockwise to increase the reading.

894. In setting either scale No. 3 must be trained to hold the fuse setter so that he looks squarely at the scales and their indices.

895. No. 3, equipped with a fuse setter, is practiced in setting the scales of the fuse setter by command. The instructor commands, for example:

1. **Corrector, 58.**
2. **4,500, or zone 1 (2).**
3. **1,500 (2,500).**

1. No. 3 sets off the corrector ordered.
2. Sets the range index for the zone ordered.
3. Sets the range scale.

The instructor verifies the settings.

896. The corrector having once been announced, changes i the corrector are usually made by the command: **Up (Dow (so much).**

The command up means that the corrector reading is to be increased; **down** means that the corrector reading is to be diminished.

No. 3 is practiced in this method as follows:

The corrector having been set at 58, the instructor commands, for example:

1. **Up, 5.**
2. **3,400.**

1. No. 3 increases the corrector reading by 5 points and, accordingly, sets corrector 63.
2. Sets the range at 3,400.

The instructor verifies the settings.

897. As soon as the data is announced No. 3 sets the fuse setter promptly at the corrector, zone, and range ordered. If percussion fire is ordered, No. 3 keeps his fuse setter set for the range and zone ordered, in order to be ready to pass promptly to time fire at any moment.

To Set the Fuse.

898. The projectile being held upright by Nos. 5 and 6 or Nos. 7 and 8, with its base on the loading barrow, its waterproof hood stripped off, and the safety wire removed (**904**), No. 3 places the fuse setter squarely upon the fuse so that the lug on the movable time train of the fuse enters the slot in the fuse setter. The line of zeros of the range scales on the fuse setter are directly over this slot in the under side of the fuse setter, and before attempting to place the fuse setter upon the fuse No. 3 turns the fuse setter in his hands so that this line of zeros will be directly over the lug on the fuse ring. Pressing the fuse setter firmly against the fuse he then turns the instrument with a steady and uniform motion in the direction indicated by the arrow mark until the lug of the fuse setter engages the stop pin of the fuse.

No. 3 then removes the fuse setter from the fuse, being careful to lift it squarely off so as not to derange the fuse setting.

SECTION VII.—DUTIES IN DETAIL OF No. 4.

899. The duties of No. 4 in the service of the piece are:

1. Procures the shot tongs.
2. Indicates the projectile to be used.
3. Draws the projectile from the chest.
4. Replaces the shot tongs.
5. In time fire, removes waterproof hood and safety wire.
6. Secures a powder charge.
7. Removes the diaphragm.
8. Prepares the charge for zone 1 or 2, if necessary.
9. Inserts charge in the breech.

The Shot Tongs.

900. At the first command for firing, No. 4 procures the shot tongs.

The Projectile.

901. The ammunition furnished for the 6-inch howitzer consists of common shrapnel and high-explosive steel shell. No. 4 must be able to identify either projectile instantaneously, even when the projectile is in the chest. He must keep himself constantly informed as to what kind of projectiles are contained in the chests of the limbers and caissons pertaining to his section and the number of each on hand at any time.

Each projectile is issued filled and fused. Its weight is 120 pounds. The ammunition chests of the battery are of the proper size to take either class of ammunition.

Indication of the Projectile.

902. As soon as he learns what kind of projectile is to be used, No. 4 indicates to Nos. 5 and 6 or to Nos. 7 and 8 the chest and the particular projectile to be used, springs to the chest, and when Nos. 5 and 6 or Nos. 7 and 8 have placed the loading barrow at its base, he reaches over the barrow from the rear, grips the base of the projectile with the tongs, and draws the projectile upon the barrow until its base is against the tray stop.

Replacing the Shot Tongs.

903. As soon as the projectile has been withdrawn, No. 4 replaces the shot tongs on the chest door handle.

Water Proof Hood, Safety Wire.

904. The fuse of each shrapnel is provided with a waterproof hood of thin brass, which hermetically seals the fuse and protects its time train from the action of the weather. In time fire, when the shrapnel has been withdrawn from the chest, Nos. 5 and 6 or Nos. 7 and 8 lower the barrow to the ground and turn the projectile point up with its base resting on the barrow. No. 4 immediately strips off the hood and withdraws the safety wire.

Whenever a shrapnel has had its safety wire removed, it must never be replaced in the ammunition chest until the safety wire

has been reassembled in the point of the fuse in order to lock the concussion plunger in place.

If the fuse has been moved from safety, it must be reset at safety before the shrapnel is replaced in the chest. These precautions are necessary to prevent the shrapnel exploding in the chest.

The Powder Charge.

905. The powder charge consists of a **brass cartridge case** containing three separate **bags** of smokeless powder secured to the cartridge case by strings and held in place by a metal diaphragm. The diaphragm is held in place by a **soldering strip.** In the base of the cartridge case is a **percussion primer.** When the cartridge case is placed in the howitzer, the primer is exploded by the blow of the firing pin and flame from the primer is communicated to the powder charge by suitable priming charges of black powder. **No. 4 must exercise great care in handling the cartridge case not to place its base on anything that might explode the percussion primer.**

906. The powder charge in the cartridge case is made up in three separate bags in order that the charge may be reduced for zones 1 and 2 by withdrawing certain bags. The reduction in the powder charge is provided for cases where a greater angle of fall of the projectile is necessary in order to reach objectives behind cover. When the firing is to be in zone 3. the full powder charge is used: when the firing is to be in zone 2, the topmost bag is removed before firing: when the firing is to be in zone 1, the topmost bag and the center bag are removed before firing.

907. The powder charges are transported in the **cartridge-case carrier.**

908. As soon as No. 4 has withdrawn the projectile in case of shell fire and has stripped the waterproof hood a removed the safety wire in the case of time fire, he procures powder charge.

To Prepare the Powder Charge.

909. In all cases of firing, that is, whatever the zone to b used, No. 4 pulls off the soldering strip and removes the diaphragm, which he places under the carriage.

910. If zone 2 has been announced, No. 4 then removes the topmost bag in the charge.

911. If zone 1 has been announced, he removes the topmast bag and the center bag. He throws the bag thus removed, if any, clear of the carriages of his section.

To Insert the Powder Charge.

912. As soon as the projectile has been rammed, No. 4 springs to the breech, holding the prepared powder charge in both hands and inserts it in the breech, shoving it smartly home. The closing of the breech block completes the seating of the cartridge case.

913. No. 4 then procures the shot tongs again and withdraws another projectile of the same kind as the previous one and prepares it and another powder charge as before in the absence of any change in command.

SECTION VIII.—DUTIES IN DETAIL OF NOS. 5 AND 6.

914. The duties of Nos. 5 and 6 in the service of the piece are:

1. Turn the trail handspikes back on the trail as soon as the piece has been given its approximate direction.
2. Procure a loading barrow.

3. Receive the projectile.
4. In time fire, assist in the preparation of the projectile.
5. Transport the projectile to the breech.
6. Prepare to receive another projectile.

The Loading Barrow.

915. At the first command for firing, Nos. 5 and 6 pick up the loading barrow, No. 5 on the right of the barrow, No. 6 on the left, both cannoneers grasping the handles of the barrow with both hands.

To Receive the Projectile.

916. Nos. 5 and 6 move briskly to the chest indicated by No. 4, and when No. 4 indicates the projectile to be withdrawn they raise the barrow until its tray is in position to receive the projectile.

To Assist in Preparing the Projectile.

917. In the case of time fire, as soon as the shrapnel is on the barrow Nos. 5 and 6 step back clear of the chest and lower the barrow to the ground. Both cannoneers kneel by the barrow and, seizing the projectile, elevate the fuse end so that the projectile is upright resting on its base, and hold the projectile in this position until No. 4 has removed the waterproof hood and the safety wire and until No. 3 has set the fuse. Nos. 5 and 6 then lay the projectile on its side in the barrow, base to the rear of the barrow, grasp the handles as before, and raise the barrow from the ground.

Transporting the Projectile to the Breech.

918. As soon as the fuse has been set in the case of time fire, and as soon as the projectile has been drawn from the chest

by No. 4 in the case of percussion fire, Nos. 5 and 6 with
row between them move briskly to the end of the
thence up to the breech, No. 5 passing along the r
trail, No. 6 along the left; they then raise the barr
the breech recess guide of the barrow in the breech r and
hold the barrow firmly in that position while No. 2 the
projectile home.

Preparation to Receive Another Projectile.

919. As soon as the projectile has been rammed and
clear of the trail, Nos. 5 and 6 still holding the barrow b
them, move backward from the breech until they are
the trail and return briskly to the ammunition c
where they stand ready to receive [illegible] projectile
it is indicated by No. 4. Nos. 5 [illegible]
they do not interfere with No. 2 in ramming nor when
from the trail with No. 4 in bringing up the pov

SECTION IX.—DUTIES IN DETAIL OF NOS. 7 AND 8.

920. The duties of Nos. 7 and 8 in the service of the
No. 7 performs the duties of No. 5 and No. 8 the duties of
6, using the second loading barrow when ammunition
drawn from the caisson limber. When specially or
7 and 8 may be required to alternate with Nos. 5
serving projectiles.

921. Upon going into action Nos. 7 and 8 may be uti
the construction of concealment for the carriages,
trail trench, etc., etc., Nos. 5 and 6 carrying all the pr
f the battery is actually firing. This work is done un
mmediate supervision of the executive or his assistant.

SECTION X.—TO SHIFT THE TRAIL.

922. All of the cannoneers assist in this maneuver of the service of the piece.

The instructor commands: 1. **Muzzle,** 2. **Right (Left).** The gunner repeats the command and brings the piece to the center of traverse. No. 1 releases the brake. Nos. 6 and 2 extend the trail handspikes and take post, No. 6 at the right, No. 2 at the left handspike; Nos. 5, 4, 7, and 8 spring to the right and left trail handles and the right and left upper trail handles, respectively; No. 1 to the right wheel, No. 3 to the left wheel. As soon as the trail has been properly shifted the gunner calls **posts.** No. 1 sets the brake, Nos. 2 and 6 turn the handspikes over on the trail, and all the cannoneers resume their posts.

SECTION XI.—COMBINED TRAINING AT THE PIECE AND AT THE CAISSON.

923. The duties at the howitzer are mutually dependent. So, also, are those at the caisson.

For this reason it is advisable, at an early stage, to combine the training of the gunner and the various cannoneers as follows:

Gunner and No. 1.
Nos. 2, 5 (7), and 6 (8).
Nos. 3, 4, 5 (7), and 6 (8).

924. After the cannoneers are thoroughly instructed, they are permanently assigned to those positions in which they have shown themselves most capable.

CHAPTER III.

EXERCISES PRELIMINARY TO INSTRUCTION OF THE FIRING BATTERY.

SECTION I.—GENERAL PROVISIONS.

929. Coincident with instruction in their individual duties and in matériel, the recruits are taught the composition and formation of the gun squad and its duties in all those exercises which are preliminary to the establishment of the pieces in position to fire (170–204).

930. The efficient service of the piece depends upon the orderly cooperation of the members of the gun squad, as well as upon the skill of the individual cannoneers. The habit of combined effort must hence be acquired.

931. An alert and soldierly manner is exacted of the cannoneers. Accuracy and exactness are the first considerations, but the cannoneers should be taught, with the acquisition of accuracy, to perform their duties briskly and rapidly. The object in view is the gradual development of great rapidity of service without reduction of accuracy. To delay too long in pushing the development of rapidity leads to inattention, slovenly service, and an actual loss of accuracy. On the other hand, striving for rapidity before the training has sufficiently progressed, is certain to result in great and frequent errors.

932. On account of their value in developing the recruit, fixing his attention, improving his control over mind and muscles, and varying the monotony of instruction, the training of recruits in the exercises of the gun squad should begin after first two or three days of individual instruction.

933. Movements of the carriages by hand, the formation of the gun squads, the posting of the cannoneers, etc., are of value in developing the alertness of the recruits if it is insisted that such movements be performed at the double time and smartly. As the training progresses the command for one of these exercises should more and more closely follow the execution of the previous one. The older men also must be frequently exercised in such movements if the smartness of the gun squads is to be preserved.

934. Steps must be taken to make the position of cannoneer attractive and to encourage the gun squads to develop teamwork to the utmost.

935. In the instruction of the gun squads it is usually best to exercise four squads as a firing battery. When practicable, chiefs of sections should be present at all drills of gun squads.

The battery commander should frequently conduct the drill of the gun squads to the end that the men may become accustomed to his voice and method of giving commands. In any event the drill must be under the direct supervision of an experienced and capable officer. This training is too important to trust it to an inexperienced officer except under the closest supervision.

936. When for any reason it is desirable to drill less than four gun squads, the commands and methods are similar to those for the complete firing battery.

SECTION II.—TO MOVE BY HAND THE CARRIAGES UNLIMBERED.

937. 1. **Pieces (caissons or limbers) forward (backward),** 2. **MARCH,** 3. **HALT**

Pieces forward: The gunner repeats the command. No. 1 replaces the brake. Nos. 6 and 2 extend the trail handspikes and take post. No. 6 at the right. No. 2 at the left handspike. Nos. 5, 4, 7, and 8 spring to the right and left trail handles and the right and left upper trail handles, respectively, No. 1 to the right wheel, No. 3 to the left. At the command **heave of the gunner** all working together move the piece forward. At the command halt, repeated by the gunner, No. 1 sets the brake, Nos. 2 and 6 turn the handspikes over on the trail, and all the cannoneers resume their posts.

Pieces backward: Executed as explained for **pieces forward**, except that the piece is moved to the rear.

Caissons (limbers) forward: The caisson corporal repeats the command. In a gun section, Nos. 4, 5, 6, 7, and 8 hasten to the designated carriage, No. 4 releases the brake, if the caisson is to be moved. These cannoneers take post at the carriage as follows: Nos. 4 and 5 in rear of the chest; Nos. 6 and 7 at the wheels; even-numbered cannoneers on the right, odd numbers on the left; No. 8 at the connecting pole (limber pole). At the command **heave of the caisson corporal** all working together move the carriage forward. The chief of section may assign Nos. 1, 2, and 3 to assist if necessary. In a caisson section the available cannoneers are assigned to posts at the discretion of the chief of section. If the caissons are separated while unlimbered, as is the usual case, No. 4 assigns the available cannoneers in the absence of the chief of section. At the command **halt**, No. 4 sets the brake if the caisson has been moved and all the cannoneers resume their posts.

Caissons (limbers) backward: Executed as explained for **caissons** (limbers) forward, except that Nos. 4 and 5 take post in front of the chest and the carriage is moved to the rear.

SECTION III.—PREPARATION FOR ACTION AND MARCH (

938. The carriages being in position limbered or unlim **PREPARE FOR ACTION.**

Each member of the gun squad performs his duties in order given below:

Gunner: (*a*) Removes the hood from the sight bar.

(*b*) Removes the sight shank from its case and places sight shank in the sight standard, setting the range at 3 in zone 3, the elevation level scale at 300 and the peep s deflection at zero, in the absence of any command to the trary.

(*c*) Takes the panoramic sight from No. 2 and places sight in its seat, making sure that the sight is clamped that the deflection is set at zero.

(*d*) Assisted by No. 3, raises and fastens the top shield.

(*e*) Operates the traversing and elevating gear.

(*f*) Seats himself on the gunner's seat.

No. 1: (*a*) Assisted by No. 3, removes the breech cover i is in place and throws it to the right rear of the trail.

(*b*) Equips himself with a wiping cloth and a lany slinging the lanyard over his right shoulder and hooking ends together under his left arm.

(*c*) Operates the breech mechanism, examines the bre block, bore, and chamber, cleaning any parts requiring leaving the breech open except when the gun is loaded.

(*d*) Seats himself on the trail seat.

No. 2: (*a*) Procures the panoramic sight and hands it to gunner.

(*b*) Assisted by No. 6, lowers the apron of the piece.

(*c*) Distributes tow or waste to the cannoneers.

(*d*) Takes his post (**187**) at the caisson limber

No. 3: (*a*) Removes the muzzle cover.

(*b*) Equips himself with a fuse setter, slinging the case strap over his left shoulder and under his right arm.

(*c*) Assists the gunner in raising the top shield.

(*d*) Removes the fuse setter from its case and sets it, corrector 60, zone 3, range 3,000, in the absence of a command to the contrary.

(*c*) Takes his post (187), fuse setter in hand.

No. 4: (*a*) Assisted by No. 5, lowers the apron of the caisson and opens the caisson chest.

(*b*) Assisted by No. 5, removes the loading barrows from their brackets.

(*c*) Takes the upper loading barrow, extends its handles, and stands it on the ground against the caisson limber wheel between the chest and the wheel farthest from the piece, tray stop of the barrow down and convex side of the tray next to the wheel.

(*d*) Draws from the caisson chest a cartridge-case carrier, opens it, and lays it on the ground under the parallel to the bottom edge of the lower chest door.

(*e*). Assists No. 5 to open the caisson limber.

(*f*) Takes his post (187).

No. 5: (*a*) Assists No. 4 in lowering the apron of the caisson.

(*b*) Assists No. 4 in removing the loading barrows from their brackets.

(*c*) Takes the lower loading barrow, extends its handles, and stands it on the ground against the caisson wheel between the chest and the wheel farthest from the piece, tray stop of the barrow down and convex side of the tray next the wheel.

(*d*) Unfastens the shot tongs of the caisson and places them above the upper chest door, the ends of the tong handles under the chest door handle on the side farthest from the piece, tongs resting on the edge of the door, handles extending to the front (*e*) Assists No. 4 to open the caisson limber.

(*f*) Unfastens the shot tongs of the caisson limber and places them on the limber door, as prescribed for the caisson tongs on the caisson door.

(*g*) Takes his post (187).

No. 6: (*a*) Assists No. 2 to lower the apron of the piece.

(*b*) Prepares the rammer for use and lays it on the ground, head resting on the breech cover 2 yards in rear of the ends of the handspikes, staff extended to the rear.

(*c*) Takes his post (187).

No. 7: (*a*) Procures the necessary tools and assists No. 8 in digging a trench for the trail, if ordered.

(*b*) Takes his post (187).

No. 8: (*a*) Procures the necessary tools and assists No. 7 in digging a trench for the trail, if ordered.

(*b*) Takes his post (187).

In a caisson section at the command prepare for action, Nos. 4, 5, and 6 of the first caisson and Nos. 4, 5, 6, and 7 of the second caisson perform the duties prescribed for Nos. 4, 5, 6, and 7 of a gun section, so far as they relate to the preparation of their caisson and its limber for action.

The cannoneers report to their chief of section if any of the parts of the matériel are out of order.

After firing the diaphragms are stored with the empty cartridge cases and the unused bags of powder are destroyed.

To Remove the Loading Barrows.

The piece being in the firing position and unlimbered, to remove the loading barrows: No. 4 stands on the left and No. 5 on the right side of the trail, facing it; No. 4 removes the loading barrow pin, grasps the left forward handle supports of both barrows with the left hand, and grasps the left rear handle supports similarly with the right hand. In the same manner No. 5 grasps the right forward and rear handle supports with his right and left hands, respectively; together they turn the barrows until they are clear of the brackets, No. 4 moving his hands to the rear and No. 5 his to the front; No. 4 lowers and No. 5 raises the right hand; the barrows are turned slightly and lifted clear of the trail.

939. The carriages, limbered, may be prepared for action before reaching the firing position. The duties of the cannoneers are the same as at the carriages unlimbered, except that the breech is closed; the firing pin is released; the panoramic sight is left in its case; the aprons are not lowered; the loading barrows, cartridge-case carriers, shot tongs, and rammer are left in place on the carriage; the breech, muzzle, and sight-bar covers are fastened to the carriage and the caissons and caisson limbers are not opened.

Immediately after establishing the carriages in position the preparation for action is completed without command and the cannoneers take their posts for serving the piece.

940. If **prepare for action** has not been given before establishing the carriages in the firing position, that command is habitually given by each chief of section as soon as the carriages have been unlimbered and established. The instructor may, however, caution **do not prepare for action** when he wishes to exercise the personnel in limbering and unlimbering only or in the details of preparation for action.

Posts of the Cannoneers, Carriages Unlimbered and Prepared for Action.

941. The same as when **unlimbered and not prepared for action** (**187**) except that the gunner and No. 1 are seated astride the trail seats on their respective sides facing **the howi** During the service of the piece Nos. 2, 3, 4, 5, 6. 7, **and 8** r such positions as best to insure orderly and rapid **service of th** piece.

To Resume the Order for Marching.

942. The carriages being prepared for action, limbered **or un**limbered. to resume the order for marching: **MARCH ORDER**

Each member of the gun squad performs his **duties in th** order given below:

Gunner: (*a*) Hands the panoramic sight to No. 2.

(*b*) Removes and replaces the sight shank.

(*c*) Assisted by No. 3 lowers the top shield.

(*d*) Secures the hood on the sight bar.

(*e*) Brings his piece to the center of traverse.

(*f*) Takes his post (187).

No. 1: (*a*) Releases the brake of the piece, if set.

(*b*) Replaces the lanyard in the trail box.

(*c*) Sees that the piece is unloaded, closes the breech.

(*d*) Assisted by No. 3 replaces the breech cover if ordered.

(*e*) Takes his post (187).

No. 2: (*a*) Takes the panoramic sight from the gunner an replaces it in its box.

(*b*) Assisted by No. 6 raises and secures the apron **of th** piece.

(*c*) Takes his post (187).

No. 3: (*a*) Replaces the muzzle cover.

(*b*) Assists the gunner in lowering and fastening the to shield.

(*c*) Replaces the fuse setter in the trail box.

(*d*) Takes his post (187).

No. 4: (*a*) Returns the upper loading barrow to the howitzer and, assisted by No. 5, replaces both barrows in their brackets.

(*b*) Assisted by No. 5, raises and secures the apron of the caisson, replaces cartridge cases, if ordered, replaces cartridge-case carriers in the caisson chest and the caisson shot tongs in their fastenings, closes the caisson doors.

(*c*) Assisted by No. 5, replaces cartridge cases, if ordered, replaces cartridge-case carriers in the caisson limber chest and limber shot tongs in their fastenings, closes the limber doors.

(*d*) Takes his post (187).

No. 5: (*a*) Returns the lower loading barrow to the howitzer and assists No. 4 to replace both barrows in their brackets.

(*b*) Assists No. 4 to raise and secure the apron of the caisson, to replace cartridge cases, if ordered, and to replace cartridge-case carriers in the caisson chest, to replace the caisson shot tongs in their fastenings, and to close the caisson doors.

(*c*) Assists No. 4 to replace cartridge cases, if ordered, to replace cartridge case carriers in the caisson limber chest, to replace the limber shot tongs in their fastenings and to close the limber doors.

(*d*) Takes his post (187).

No. 6: (*a*) Assists No. 2 in raising and securing the apron of the piece.

(*b*) Unscrews the rammer staff and secures it in its fastenings.

(*c*) Takes his post (187).

No. 7: Has no routine duties.

No. 8: Has no routine duties.

In a caisson section at the command **march order**, Nos. 4, 5, and 6 of the first caisson and Nos. 4, 5, 6, and 7 of the second caisson perform the duties prescribed for Nos. 4, 5, 6, and 7 of a gun section so far as they relate to the preparation of their limber and caisson for march order.

To Replace the Loading Barrows.

The piece being in the firing position and unlimbered, to place the loading barrows: No. 4 folds the handles of his barr and carries it to the left side of the trail; holds it across t trail, bottom of the barrow up and tray stop to the rear, order for No. 5 to grasp the handle supports; similarly No. carries his barrow to the right side of the trail and holds below No. 4's barrow, for No. 4 to grasp the handle supports both cannoneers then grasp both barrows as described in paragraph 965; No. 4 lowers and No. 5 raises the right hand; the barrows are turned slightly, lowered between the flasks of the trail, and turned again so that the left forward handle supports are just in rear of their bracket in the proper opening of the left reinforce plate, and the right rear handle supports are in the proper opening of the right reinforce plate; No. 4 raises and No. 5 lowers the right hand; the barrows are turned, No. 4 moving his hands to the front and No. 5 his to the rear; and the barrows are seated in their brackets one at a time, beginning with the lower one. No. 4 replaces the loading-barrow pin.

943. If it is intended to resume the fire but in another position, so that the limbering of the carriages is necessitated, the command **march order** need not be given. At the command for limbering, the carriages are placed in the order described in paragraph **939.**

CHAPTER IV.

THE FIRING BATTERY AND THE DUTIES OF ITS GUN SQUADS.

SECTION I.—COMPOSITION, FORMATION, AND INSTRUCTION OF THE FIRING BATTERY.

944. The firing battery comprises the guns, caissons, and caisson limbers of the first six sections of the battery, with the personnel and animals assigned to their immediate service. It is under the direct command or orders of the captain. The most suitable lieutenant (**32**) of the battery is selected for the immediate command of the firing battery when the battery commander is at some distance from the pieces, and for the immediate supervision of the personnel when the battery commander is near enough to the firing battery to give his orders and commands by word of mouth. This lieutenant is the executive. When the number of lieutenants present permits, the executive has a junior lieutenant assigned as his assistant.

945. For the instruction of recruits the drill of the gun squads is at first carried on in the park. Later the instruction of the firing battery is carried on over all forms of terrain available.

In the field it is desirable that the pieces be placed approximately in line with regular intervals of 20 yards between adjacent muzzles. It is more important that the intervals be regular than that they be exactly 20 yards. Each chief of sections cautions **(such) piece, or No. (so and so)**, as soon as his carriages have been established in position (47). In the park, vals, distances, and alignment of the firing battery are important, so long as the squads do not interfere with eac in their maneuvers.

946. At the commencement of training of recruits i duties in the firing battery their instruction in the elen principles of gunnery contained in this chapter will be As the instruction progresses and the recruits are divid classes each class should be instructed in so much of th ciples involved in service firing as the men of any pa class can thoroughly grasp.

SECTION II.—DUTIES IN GENERAL OF OFFICERS OF THE BATTERY AND OF THE NONCOMMISSIONED OFFICERS OF T SECTIONS.

947. Captain:

Commands the firing battery and, as a rule, conducts t

948. The executive:

1. Usually conducts the firing battery to and establish the firing position. Causes such measures to be taken facilitate the rapid opening of accurate fire. Sees to th aration of all practicable protection for the personnel i tion to that provided by the shields.

2. Exercises immediate command of or supervision o battery in the firing position.

3. Repeats all firing data when the captain is not near the battery to command it by voice.

4. Gives the command for commencing firing wheth captain be at the battery or not. The command by the tive is **Fire**. It is usually accompanied by a signal m bringing the extended right arm from a vertical position s to the side. For salvos the executive gives the command

soon as he sees that all the pieces will be ready to fire in their proper turn. For volleys he may give the command **fire** immediately after the range has been announced or he may wait until all the pieces are ready, according to the instructions of the captain.

5. Assisted by the chief mechanic attends to the resupply of ammunition, under such general instructions as the captain may give.

6. Has charge of the replacement of casualties.

949. Assistant to the executive:

Assists the executive in the supervision of the gun sections, especially when difficulties or errors occur in a gun squad.

950. Chief of gun section:

1. Commands his section.

2. Makes sure of the identification of his part of the target or of the aiming point.

3. Keeps informed of the firing data so as to be able to repeat any parts not understood by the cannoneers but does not repeat anything unless it is called for by a subordinate. If a chief of section does not understand any item of the firing data he asks the executive for it thus: Site? Corrector? etc.

4. In indirect laying whenever the trail has to be shifted, puts the gunner approximately on the aiming point by glancing along one side of the rotating head of the panoramic sight and causing the trail to be shifted until the side of the rotating head is in line with the aiming point (**897**).

5. Commands **with the lanyard** for the first shot when the ground is such that the trail spade is not easily seated, and sees that all the cannoneers step clear of the piece for the first shot.

6. Extends his right arm vertically as soon as the gunner has called **ready**, so as to indicate to the executive officer that

the piece is ready to fire. The right arm is held **vertical** ı his gunner commands **fire.**

7. Supervises and is responsible for all the details **of cor** service by his gun squad.

951. Gunner:

1. Performs his duties in the gun squad.

2. Commands **muzzle right (left)** when he has reached t limit of traverse of the gun on the carriage.

3. Commands **fire** so that his piece will be fired, **after havin** been accurately laid, at the proper time.

SECTION III.—MEASURES FOR FACILITATING THE RAPID OPENIN OF FIRE.

952. Early opening of effective fire is facilitated by accurate establishment of the firing battery in the firing position without undue haste or confusion. To this end all officers, noncommissioned officers, and men will take particular care that the carriages are regularly and methodically established and quickly prepared for action. Commands are to be given by the proper individuals. Unnecessary conversation and laxity in the work of getting the guns into position leads to delay and poor fire discipline.

953. If fire is not to be opened immediately upon occupying the position, a semicircular trench should be dug for the trail spade. If fire is opened at once it is always advisable to dig such a trench during the lulls in firing. Such a measure gives great facility in shifting the trail and is especially valuable in firing at moving targets.

954. The targets for light field guns are most frequently at a site of about 300 and at ranges near 3,000 yards. Hence the etting of sights quadrant [illegible] fuze setters at Site 300, Cor-

rector 30, Range 3000, in the absence of exact data, and the leveling of instruments tend to hasten the opening of fire. If indirect laying is to be used the aiming point is usually known as soon as the carriages are unlimbered.

Since the front of the battery is usually established about perpendicular to the direction in which fire is to be delivered, the head of the panoramic sight should be turned on the aiming point as soon as the gun, prepared for action, is fully established in its position.

It is frequently practicable to communicate most of the firing data and to set the instruments before occupying a position, or at least some time before the fire is to be opened.

If no target is visible or none has been assigned to the battery when the position is occupied, the captain selects a prominent point near the center of the sector he is to cover and causes the guns to be laid upon it.

SECTION IV.—DEFLECTION AND DEFLECTION DIFFERENCE.

955. Each gun in the battery must be so pointed that its projectile will fall in the direction of its part of the target.

956. The direction of each gun may be given by setting the sight at zero, then bringing the cross hairs on the target by shifting the trail and traversing the gun on the carriage.

Or, the direction of the gun may be given by setting the sight at a reading, called the **deflection,** previously determined and then bringing the vertical cross hair on a designated aiming point by shifting the trail and traversing the gun on its carriage.

957. When the guns are laid for direction by bringing the cross hairs on the target, each gunner sights at and his projectiles should fall on his own part of the target.

When the guns are laid for direction by bringing the vertical cross hairs on an aiming point it is usually necessary to give the guns different deflections in order that each piece may be brought on its own part of the target. The difference in deflections is called the deflection difference. It is usually small and is the same for any two adjacent pieces.

958. By opening out the guns like a fan, the front covered by the fire is increased; by closing in the guns, the front covered may be decreased. By increasing or diminishing the deflection difference, therefore, the front on which the projectiles fall may be increased or decreased at will.

The lines of fire of several pieces collectively directed form the sheaf of fire.

959. When an aiming point is used, the captain, assisted by his battery detail, determines the deflection for one of the pieces and the amount by which the other pieces must be opened out or closed in on this one in order that the shots may fall on the front desired.

The piece for which the deflection is determined or on which the others are to close or open is indicated by the number of the piece given in the command: **On (such) piece, Open (close)** (so much). This piece is called the directing piece.

960. Since the deflection difference for any two adjacent pieces is the same, each gunner must multiply the deflection difference by the number of gun intervals between his piece and the directing piece in order to find the amount by which his deflection will differ from that of the directing piece.

961. The gunner of the directing piece does not change his deflection on account of the deflection difference.

In order to open out the sheaf the guns on the right of the directing piece must have their muzzles moved to the right and those on the left of the directing piece must have their muzzles moved to the left. Since decreasing the deflection moves the muzzle to the right and throws the shot to the right, each gunner on the right of the directng piece, in order to open the sheaf, must multiply the deflection difference by his number of intervals from the directing piece and subtract the result from the deflection announced. Since increasing the deflection moves the muzzle to the left and throws the shot to the left, each gunner on the left of the directing piece, in order to open the sheaf, must multiply the deflection difference by his number of intervals from the directing piece and add this result to the deflection announced.

962. Conversely, to close the sheaf on the directing piece, the gunners on the right must increase the deflection or add to it so as to throw the muzzles of their guns toward the directing piece, while those on the left must decrease the deflection or subtract from it in order to throw their muzzles toward the directing piece.

963. When the aiming point is in certain positions it may happen that the fire will be properly distributed on the target when the deflection of all the pieces is the same, or when the deflection difference is zero. The absence of any command **open** or **close** is the indication that all the pieces are to be laid with the same deflection.

964. After the first or subsequent firing, one of the guns may be directed on its part of the target while the others are not. In such cases the captain does not change the deflection but brings all the guns on the target by opening or closing on the gun which has the proper direction.

965. The gunners are trained in setting off the corrected deflection individually as well as during the instruction of the gun squads.

For example: 1. **Deflection 1620**, 2. **On 1st piece, Open 10.** A the gunners set 1620 as soon as it is announced. As soon **On 1st piece, Open 10** is given the gunner of the 2d piece mu plies 10 by his interval (one) and adds the result (10) to 162 and accordingly sets 1630. The gunner of the 3d piece mult plies 10 by his interval (two) and adds the result (20) to 162 and accordingly sets 1640. The gunner of the 4th piece mult plies 10 by his interval (three) and adds the result (30) 1620, and accordingly sets 1650.

The sights being set as above, for example, the com may be: **On 3d piece, Close 5.** The third piece becomes directing piece and its gunner leaves his sight reading at 1 The gunner of the 4th piece multiplies 5 by his interval (one subtracts the result (5) from 1650, and accordingly sets 1 The gunner of the 2d piece multiplies his interval (one) adds the result (5) to 1630, and accordingly sets 1635. T gunner of the 1st piece multiplies his interval (two) by 5, ad the result (10) to 1620, and accordingly sets 1630.

The instructor verifies the settings.

966. It is most important that all the gunners first set th deflection ordered and then apply the deflection differenc This method avoids errors and results in greater rapidity tha is obtained should the gunner attempt to make all of his calc lations and then to set off the resulting deflection.

967. It may be that the aiming point can be seen from onl one piece. In such cases the executive, after announcing th deflection, commands: **Lay on (Such) piece**, designating th piece from which the aiming point can be seen. At this com mand each chief of section, except that of the piece designate causes his gunner to turn his sight in the direction of th designated piece and his No. 2 to extend the rammer sta vertically in front of the object glass of the sight. The designated piece having been accurately laid at the indicated deflection, its chief of section causes the gunner to turn his sight, **without traversing the piece,** so that the vertical hair will bisect the rammer staff at the other pieces in succession and announces the reading, thus: **No. (So and so), (So much).** The chief of section of the piece which can see the aiming point then causes No. 2 to extend his rammer staff vertically alongside the sight.

As the reading for his piece is called off, each chief of section who is unable to see the aiming point subtracts 3,200 from the reading announced if he is on the left of the piece from which the aiming point can be seen, or adds 3,200 to the reading if he is on the right. He then causes the gunner to set his sight according to the result thus obtained and to lay on the rammer staff at the designated piece. This results in the guns being laid so that the axes of the bores are parallel.

Each chief of section then selects his own aiming point and causes the gunner to measure the deflection **(868).**

968. The necessity for taking full advantage of cover for the concealment of the guns, especially from aircraft, may sometimes make it impossible to utilize a common aiming point or to see one piece from another. In such cases the executive causes the pieces to be pointed, by the compass or other means, as nearly as may be in the proper direction. One of the pieces is selected to fire a single round of time shrapnel so as to give a burst about 10 mils above the horizon visible from the guns and at as great a range as practicable. The remaining pieces are so elevated and the sights are so set as to enable each gunner quickly to turn the rotating head of his panoramic sight upon the burst without disturbing the laying of the piece. Each chief of section, having noted the deflection, causes the gunner to turn the sight on any suitable aiming point without disturbing the laying. The reading on the aiming point selected is then diminished by the reading on the burst if this latter reading was less than 3,200. If the reading on the burst was greater than 3,200 the reading on the selected aiming point is increased by the difference between the burst setting and 6,400. The deflection obtained by making the corrections just indicated is then set off on each sight and each gunner brings his cross hairs on the aiming point selected by traversing the piece. This results in the pieces all being laid on the point of burst of the shot fired. By suitable commands for opening the captain forms the sheaf.

969. Having once formed the sheaf, the captain may change its direction by announcing a new deflection or by the command: **Right (Left), (So much).** At the command, for example, **Right 30**, each gunner subtracts 30 from his deflection, sets his sight at the new deflection, and brings his vertical cross hair on the aiming point by traversing the piece. Each gunner has then moved the muzzle of his gun to the right through an angle of 30 mils. Similarly, if the command be **Left 30** each gunner adds 30.

970. The direction and distribution may be changed simultaneously. At the command, for example, 1. **Left 30**, 2. **On 1st piece, Close 5**, each gunner first adds 30, and then applies the deflection difference (**965**). Having set off his correct deflection, each gunner brings his vertical cross hair on the aiming point by traversing the piece.

971. In order properly to distribute the fire, it is sometimes necessary to change the deflection of a single piece while leaving the others unchanged. The captain commands, for example, **(Such) piece, Right (Left), (So much).** The deflection of the designated piece only is changed as indicated in the command.

SECTION V.—RANGE AND SITE.

972. As the distance from the guns to the target increases the guns must be pointed more and more above the line joining the gun and the target in order that the projectile may reach the target.

973. Since targets are not always at the level of the gun, but are frequently above or below this level, the actual inclination of the gun to the horizontal when the gun is laid on a target is not the elevation due to range of the target only, but is a combination of this elevation due to range and of the difference of level between the target and the gun. When the gunner sets his sight shank at the correct range and, looking through the sight, brings the horizontal hair on the bottom of the target he automatically gives the gun the correct elevation above the line joining the gun and the target. This elevation of the gun above the line from the gun to the target is affected by the range only, and does not vary with the height of the target.

974. When the gunner does not sight directly at the target, but lays the gun for direction by sighting at an aiming point, the gun elevation must be given by the quadrant. The quadrant, therefore, has devices by which the angular elevation due to range may be set off and by which to make allowance for the difference in level between the gun and the target.

The first is accomplished by the range disk, the operator setting the range announced opposite the index.

The second is accomplished by the site device, which the operator has only to set at the value announced.

The range and site data having been set off on the quadrant and the quadrant being in place on the gun, the operator elevates or depresses the gun until the bubble of the elevation level is centered. The proper combination of these two angular values is thus automatically made and the gun has the proper inclination to the horizontal to cause the projectile to reach the target.

975. The site is announced by the captain, **Site (So and so).** Since the guns of a battery are usually on nearly the same level the site is usually the same for all the guns. Sometimes, however, it becomes necessary to give a different site to the several guns. In such cases the captain commands: **Site, No. 1 (So and so); No. 2 (So and so)**; etc. The gunner of each piece sets the site indicated for his particular piece.

976. The range is announced for each salvo or volley.

SECTION VI.—PROJECTILES, FUZES, KINDS OF FIRE.

977. There are two kinds of projectiles for the 6-inch howitzer: Common shrapnel and high-explosive steel shell. A design for a high-explosive shrapnel is being developed. A cast-iron shell has been designed.

978. The **steel shell** consists of a steel case with a bursting charge of high explosive which detonates upon striking.

The **common shrapnel** consists of a steel case containing about 1,174 bullets and a bursting charge of black powder in the base.

If the common shrapnel bursts in air the case is not ruptured, but the base charge forces the nose off and expels the bullets to the front in the general shape of a cone called the **shrapnel cone.**

979. With respect to the instant at which the projectiles burst, fire is classified as **percussion fire** and **time fire.**

In **percussion fire** the projectile bursts when it strikes; the burst is then said to be **on impact.**

In **time fire** the projectile bursts in the air before reaching the ground.

980. Bursts on impact are secured by a fuze which explodes the bursting charge upon striking. Such a fuze is a percussion

fuze. It does not have to be set but is always ready to act aft the projectile is fired.

981. Bursts in the air are secured by a fuze which can b set to explode the base charge at any time after the projectil is fired. Such a fuze is a **time fuze.** It contains a powde train which starts burning at the instant when the projectile is fired, and, when the fuze is set, burns down to the base charge in a period of time dependent on the setting.

982. For convenience the fuze setter for setting the time fuze is graduated in range. But due to errors of the fuze and other causes the base charge will not always explode at exactly the range set off. Moreover, it is sometimes necessary to vary the height of burst. For this the fuze setter is arranged to permit changing the fuze setting without changing the range reading on the fuze setter. The device for accomplishing this is called **the corrector.** A corrector of about 30 ordinarily gives a height of burst of about 3 mils as seen from the guns. This height of burst is called **normal.** Raising the corrector shortens the part of the time train which must burn before the base charge is reached and therefore raises the height of burst. Lowering the corrector lengthens the time of burning and lowers the height of burst.

983. All shells are provided with **percussion** fuzes only.

All shrapnel are provided with **combination** fuzes containing both percussion and time elements. The percussion element acts if the time element has not acted before the projectile strikes. If the combination fuze be set at safety the time element can not ct but the percussion element may.

984. The gun squads must know the kind of projectile and e fuze which are to be used. This is indicated to them by e commands: **Shell**; or, **Percussion**; or, **Corrector (So much):**

or **Up (Down) (So much).** The command **shell** indicates that shell are to be used. The command **percussion** indicates that shrapnel for percussion fire are to be used. Since shrapnel for percussion fire must have their fuzes set at safety and since the fuzes are carried at that setting in the chest, it is not necessary to use the fuze setter when the command **percussion** is given; but, as the gun squads must be ready to change from percussion to time fire, No. 3 always sets his range scale at the last range announced.

Corrector (So much); or, **Up (Down) (So much)** indicates time fire with shrapnel and that the fuzes must be set.

985. When the howitzer is laid for both range and direction by sighting through the gun sights directly upon the part of the target that the fire is intended to reach the method is called **direct laying.**

986. When the howitzer is laid for direction by sighting through the gun sights at an auxiliary objective known as the aiming point, and for range by means of the elevation level, the method is called **indirect laying.**

* * * * *

The loading and firing are stopped. The captain may command: **Cease firing; fire loaded pieces.** The loading ceases, but the firing is continued until the projectiles already rammed have been fired. All the pieces are kept laid with the last data received. The signal for cease firing is a prolonged blast on the whistle with the right arm raised vertically until the signal is obeyed.

987. For direct laying, the target must be distinctly visible through the sights; the guns must therefore be more or less exposed. For indirect laying the target need not be visible to the gunners; the guns may therefore be concealed. For these reasons and because indirect laying leaves [illegible] captain complete independence in the manipulation [illegible] of fire

and ordinarily results in great regularity of heights of burst, ranges, and distribution, it is the usual method.

988. In firing at aerial targets or at small targets moving rapidly, direct laying is advantageous because corrections for site are eliminated and changes in deflection are automatically made by keeping the cross hairs on the target.

In firing at large moving targets or at small targets slowly moving, indirect laying may be used with great facility.

SECTION VIII.—FIRE FOR ADJUSTMENT; FIRE FOR EFFECT; ACCURACY.

989. It is usually impossible to determine before firing the exact laying which will certainly give hits on the target. It is therefore necessary to correct the laying according to the captain's observation of the bursts with reference to the target. The first part of the fire at any target is accordingly conducted so as to facilitate observation. Such fire is called **fire for adjustment.**

990. The fire must always be adjusted in direction, in distribution, and in range. In time fire the height of burst must also be adjusted.

As a rule, the direction, distribution, and height of burst may be quite accurately observed and adjusted by making changes in the deflection, deflection difference, and corrector. Adjustment of the range is more difficult. It is usually impossible to determine a single range which will surely give hits on the target. On this account it is generally best to determine two ranges, one of which gives bursts short of the target and one of which gives bursts beyond the target. The determination of these two ranges is called **bracketing** the target. The difference between the two ranges is called the **bracket.**

991. Having obtained the adjustment, fire is opened at ranges and, in time fire, at a height of burst which will surely give hits on the target. This is called **fire for effect.**

992. The greatest difficulties in obtaining adjustment and the principal cause of lack of effect arise from errors in the fire. Such errors are due to inaccuracies of the personnel, to atmospheric changes, and to imperfections of matériel and ammunition. Even though the laying be exact, a single gun will not shoot precisely in the same place each time it is fired.

Inaccuracies due to the personnel are usually much greater than those due to the matériel. They result from errors in laying; from failure to set the scales exactly as ordered or to center the bubbles; from not noticing and correcting any derangement of the laying due to loading or of the settings due to firing; from not turning the projectile in the fuze setter in the proper manner; and from similar mistakes.

993. Rapidity of fire without accuracy is unprofitable. Accuracy slowly obtained must often result in lack of effect, because the enemy will have time to shelter himself from the fire. The ideal is accuracy with rapidity. This ideal can be attained by at first insisting on accuracy without regard to speed and by thereafter gradually developing it through persistent drill of the gun squads in the firing battery.

994. It must be realized that all men are likely to make mistakes. In order that the captain may not be misled, all members of the gun squads should be encouraged to detect and to report at once any errors that are made. The causes of these should be sought and reported in order that methods and matériel may be so improved as to reduce the number and effect of personnel errors.

SECTION IX.—METHODS OF FIRE.

995. The methods of fire are fire by piece, fire by salvo, volley fire, and continuous fire.

Fire by Piece.

996. The command for fire by piece is **First (second, third, or fourth) piece, only**. The designated piece only is loaded; it is fired upon the command **fire** by the executive, repeated by the gunner.

If the captain desires that the designated piece fire only upon his specific command he cautions **at my command**, and the piece is fired at the command **fire** of the captain, repeated by the gunner.

Fire by Salvo.

997. Salvos may be by **battery** or by **platoon**. The command for a battery salvo is: **Battery right (left)**. Upon the command **fire** by the executive the pieces are fired at that command of the gunners in order from right to left at intervals of about 10 seconds.

998. The command for a platoon salvo is: **Right right (left)** or **Left left (right)**.

The first word of command designates the platoon which is to fire. Thus, if the command be **Right right (left)** the first and second pieces only are loaded. Similarly if the command be **Left left (right)** the third and fourth pieces only are loaded.

The second word of the command indicates the flank from which the pieces designated are to be successively fired. Upon the command **fire** by the executive the pieces of the platoon designated are fired, at the command of the gunners, in the order prescribed at an interval of about 10 seconds.

999. The interval of 10 seconds may be increased by cautioning, after the command for the salvo, **at (so many) seconds.** The interval thus prescribed will be used as long as salvos are fired until another interval is announced.

1000. Occasionally in salvos it may be desirable to fire each piece at the specific command of the captain. The captain cautions, **at my command.** Each piece is then fired upon the command of the captain, 1. **No. (so and so)**, 2. **FIRE**, each gunner repeating the command **fire** when his piece is designated.

1001. When the method of fire is by piece or by platoon salvo, the gun squads of the pieces which are not to take part in the firing keep all the instruments set and the pieces laid in accordance with the commands. All the pieces are thus able to open fire immediately. To change from fire by single piece or platoon salvos to battery salvos the command is: **Battery right (left).** Fire by piece or platoon salvos is stopped and all the pieces take up the fire in sucession beginning at the flank designated.

1002. Fire by piece is particularly suited for the first shot in target practice. Salvos are suited for fire for adjustment on account of the facility with which the bursts may be observed.

Volley Fire.

1003. The command for battery volleys is: **Battery (so many) rounds.** Upon the command **fire** by the executive each piece fires the designated number of rounds as rapidly as possible consistent with accuracy and without regard to the other pieces. To make certain that the correct number of rounds is fired each No. 4 as he loads the piece calls out the range and the number of the round. As the last round ordered is loaded, he adds: **Last round.** Thus, the command being **Battery 2**

rounds, 3200. On loading the first round each No. 4 calls **3200, one**; on loading the second round, each No. 4 calls **3200, two; last round.**

1004. In exceptional cases it may be desirable to use one platoon only in volley fire. In such cases the command is: **Right (Left) (so many rounds.** Only the pieces in the designated platoon are loaded and fired.

1005. Volley fire is particularly suitable for fire for effect on account of the rapidity with which it may be delivered.

Continuous Fire.

1006. The command for continuous fire is: **Continuous fire, interval (so many) seconds (minutes.** If the previous fire has been by a particular piece, that piece only continues its fire at the prescribed interval. If the previous fire has been by platoon, the fire is similarly continued by that platoon only; if by battery it is continued by the battery in a similar manner. If the interval between shots is to be irregular, the captain gives the necessary instructions.

If the continuous fire is to be by piece the captain habitually causes at least one round to be fired from the piece which is to take up the continuous fire before giving the command for continuous fire. Similarly, if the continuous fire is to be by platoon or battery, he causes the designated platoon or the battery to fire at least one salvo before giving the command for continuous fire.

1007. ---

1008. ---

SECTION X.—CLASSES OF TARGETS, APPROPRIATE METHODS OF FIRE AND BRACKETS.

1009. Targets are classified with reference to their nature as artillery, infantry, machine guns, etc. They are also classified according to their movement, or power to move, as fixed or stationary, transient, and moving. All of these may, of course, vary as to size and as to degree of movement.

1010. Fixed, or stationary, targets are targets which are fixed to their position for at least a considerable time. Examples of such targets are buildings, trenches, artillery in position, troops held under cover by fire.

Transient targets are those which while fully exposed to fire are likely to remain so for a very brief time. Examples of such targets are infantry skirmish lines, machine guns, observation parties.

Moving targets are those which are changing their location. Examples of slowly moving targets are large bodies of troops on the march, infantry whether on the march or advancing to the attack, wagon trains on the march. Examples of rapidly moving targets are artillery at fast gaits, charging, cavalry, cavalry at fast gaits, small bodies of mounted men, motor cars.

1011. Against all fixed targets salvos are ordinarily used in fire for adjustment, which is usually continued until a suitable bracket has been obtained.

1012. Against transient targets it is necessary to be content with a wider bracket. In extreme cases it may be desirable to assume a bracket of considerable depth based on the observation of the first bursts. Transient targets are usually attacked with shrapnel. Salvos are usually appropriate during fire for adjustment. Volleys are used in fire for effect.

1013. Slowly moving targets or long targets moving across the line of fire are attacked by shrapnel in the same manner as fixed targets. Either direct or indirect laying may be used. During direct laying volleys are usual during adjustment as this method gives the gunner more independence in the instant of firing, and he is better able to take advantage of the moment when the target is most visible and his laying most accurate. Volleys are used in fire for effect.

1014. Rapidly moving targets or small moving targets are attacked by shrapnel in the same manner as in the extreme case of transient targets. Volleys are ordinarily used both in fire for adjustment and in fire for effect. If the target is small indirect laying is usually ineffective.

1015. When the target is moving across the line of fire and the trail has to be shifted, the gunner traverses the muzzle of the gun as far as it will go in the direction opposed to that in which the target is moving. This enables him to take advantage of the greatest possible amount of traverse on the carriage. In shifting the trail No. 2 sights along the gun and directs it on the head of the target.

SECTION XI.—FIRING DATA AND THEIR COMMUNICATION TO THE GUN SQUADS.

1016. The firing data embrace all the information and commands necessary to enable the gun squads to accomplish the orderly, rapid, and accurate service of the pieces. To this end it is essential that the firing data be communicated to the guns in an habitual sequence. First place must be given to the element of the data most essential to commencing the service of the pieces. The sequence should favor as far as possible the completion of one operation by a particular member of the gun squad before he is required to take the data for another.

1017. The necessary data for indirect laying in their habitual sequence are—

1. The designation of the aiming point.
2. The deflection.
3. The deflection difference.
4. The site.
5. The kind of projectile (corrector, shell, or percussion shrapnel).
6. The method of fire.
7. The zone.
8. The range.
9. The command, by the executive, **fire.**

1018. The necessary data for direct laying in their habitual sequence are—

1. The designation of the target.
2. The deflection.
3. The kind of projectile (corrector, shell, or percussion).
4. The method of fire.
5. The zone (if other than 3).
6. The range.
7. The command, by the executive, **fire.**

1019. Fire at will being an exceptional and special method, in which the sight and the fuse setter have fixed settings (**1008**), and direct laying with shrapnel is always used, the only firing data necessary are the designation of the target, the method of fire, and the command **fire.**

1020. It is generally possible to communicate certain items of the data before the moment for opening fire. For example, in indirect laying the aiming point may be designated and the approximate deflection and the deflection difference announced as soon as the guns are established.

1021. Except when the captain is near enough to the battery to make his voice heard by all the gun squads, the executive repeats all the firing data. Without awaiting any signal or command from the captain the executive gives the command **fire** at such time after the range is announced as will insure the orderly delivery of the fire. If the captain desires to give a range without opening fire, he cautions **Do not load** before announcing the range. To load and fire he again announces the range. To suspend the fire at any time the captain commands or signals: **Cease firing.** The loading and firing are stopped. The captain may command: **Cease firing, fire loaded pieces.** The loading ceases but the firing is continued until the projectiles already rammed have been fired. All the pieces are kept laid with the last data received. The signal for cease firing is a prolonged blast on the whistle with the right arm raised vertically until the signal is obeyed.

1022. Each gunner gives the command **fire** so that his piece will be fired at the proper time after the command **fire** by the executive. No other item of the firing data is repeated unless it is called for. When a member of a gun squad does not understand any item of the firing data he asks his chief of section for it, thus, **Site? Corrector?** etc. **(950).**

1023. The complete firing data **(1017–1018)** are always necessary before firing the first salvo or volley after occupying a position. After the first salvo or volley the captain announces only so much of the data as he desires to change, except that the range is always given as a definite signal to load and for the executive to give the command **fire** at the proper time.

In firing shell or percussion shrapnel each piece is loaded as soon as it is fired; but the range is, nevertheless, given as a definite signal for the executive to give the command **fire** at the proper time.

1024. In the exceptional cases in which the captain causes each piece to fire at his command the executive repeats the command: **No. (So and so) Fire**, unless the captain is near enough to the guns to make his voice heard by all the gun squads. Each gunner cautions fire at the proper time.

SECTION XII.—COMBINED DUTIES OF THE MEMBERS OF THE GUN SQUADS.

1025. The duties of individuals in the gun squad are not independent but are closely related. Teamwork is essential to rapidity and accuracy of fire and, therefore, to its effectiveness. Each man must exactly perform his functions without interfering with other men. Each must cooperate with and assist the others in every practicable way.

1026. To attain a high quality of teamwork the most necessary requisite is a profound knowledge by each man of his own functions and facility in executing them at high speed, reinforced by a thorough understanding of the duties of each of the other members of the gun squad.

1027. In the first combined drills it is advisable to explain exactly what each man does after the announcement of each item of the firing data. After this explanation the men should be required to perform their duties precisely but slowly. As the instruction progresses, they are urged toward greater rapidity without sacrifice of precision. When the squads are working smoothly as units, the explanations are omitted. Finally the firing data are announced with as great rapidity as is consistent with distinct enunciation.

1028. Rapidity on the part of the gunner in traversing the piece to the center of its traverse when the trail is to be shifted in indirect laying facilitates the work of the chief of section.

Similarly, for laying at moving targets the work of the cannoneers is greatly facilitated if the gunner, when the trail must be shifted, rapidly traverses the gun as far as it will go in the direction opposed to that in which the target is moving. The gunner must not interfere with the elevating mechanism in indirect laying.

1029. --

Each chief of a gun section firing, when his piece is ready, faces the executive and raises the right hand. At the latter's signal he gives the command for firing. The executive causes the piece or pieces to be fired in the appropriate order at the interval given in the command. When fired, each piece firing is loaded, laid, and made ready for the next round.

At each piece firing the chief of section requires the ramming of projectiles to be postponed as long as is possible without delaying the firing, in order that as few projectiles as possible may be left in the pieces firing when the command **cease firing** is given and also that in time fire, changes in fuse setting may be made as soon as announced.

The captain observes the fire and makes such changes in the firing data as may from time to time be necessary.

To discontinue the firing the captain commands: **Cease firing.** The loading and firing immediately cease. The captain may command: **Cease firing, fire loaded pieces**; the loading ceases but the firing is continued until the projectiles already rammed have been fired.

When the continuous fire is by single piece or platoon and is to continue for a considerable time the captain may direct that the squads at the pieces not firing remain at ease or be dismissed.

1030. --

1031. --

1032. --

Chapter V.

REPLACEMENT OF AMMUNITION AND OF CASUALTIES.

1033. The ammunition chests of the firing battery should always be kept as nearly filled as practicable. If this is not practicable, one caisson and limber for each piece should be kept filled. It is also important, especially when the supply is short, that the ammuniton be equalized among the gun sections. If it is probable that the expenditure is likely to be considerable, additional ammunition may be brought up and stored at suitable places near the pieces.

1034. In the service of the piece, if practicable, ammunition is drawn directly from any storage piles, otherwise it is drawn from the caissons and limbers of the firing battery. The empty chests are refilled from storage piles or from the combat train.

1035. When the battery is not under fire, this replenishment should be more or less continuous and may be carried by Nos. 7 and 8 of the gun sections and the cannoneers of the fifth and sixth sections under the direct supervision of the chief mechanic. When the battery is under fire, or for any other reasons, it may be advisable to take adantage of lulls in the firing of the battery and utilize all the cannoneers in bringing up ammunition.

1036. The caisson sections of the combat train are brought up and posted as near the firing battery as practicable. Upon orders from the captain or the executive, ammunition may be transferred therefrom to the firing battery:

(*a*) By hand, utilizing such cannoneers as are available.

(*b*) By bringing one or more of the combat train carriages into the firing battery by team or by hand and transferring by hand to storage or to the firing battery chests.

(*c*) By removing the empty caissons and limbers from the firing battery by team or by hand and replacing them by filled caissons and limbers brought up from the combat train by team or by hand.

In the latter case (*c*), if the carriage from the combat train is brought up by its team, the same team may be utilized to withdraw the empty carriage. This method is preferable to the others as avoiding man handling the carriages and ammunition.

1087. The exact method to be used in the resupply of ammunition to the firing battery depends upon the circumstances of the case. As a rule, such situations as render it probable that there will be a considerable expenditure of ammunition justify the accumulation of a considerable supply in suitable places near the firing battery. In such cases the caissons from the combat train may be brought up whenever conditions permit and the ammunition transferred to the supply stored on the ground or in some convenient place.

1088. Whatever the method of resupplying the firing battery from the combat train, it is desirable to use all of the men available in making the transfer, so that the teams and the empty carriages may be removed from the vicinity of the guns as rapidly as possible. No fixed rule can be given for the employment of the men in this transfer. The executive gives the necessary orders for the rapid and orderly accomplishment of the work.

1089. The executive, under the direction of the captain, ha charge of the replacement of casualties. Every effort must made to prevent the personnel with any piece in action from falling below a strength of 2 noncommissioned officers and 6 privates.

1040. As a rule each casualty in officers and noncommissioned officers is replaced by the next junior available in the unit or subunit.

The captain is temporarily replaced by the senior officer or noncommissioned officer at his station, who takes over the duties of the captain, continues the action of the battery, and notifies the senior officer of the casualty at the first opportunity.

Gunners and Nos. 3 and 4 are replaced by the best instructed men available.

1041. When man-handling the carriages, Nos. 7 and 8 are necessary members of the gun squad, but during actual loading and firing they are useful only as reliefs for the other numbered cannoneers or for transporting ammunition, and their absence from the squad does not necessitate any changes in the duties of the cannoneers. If, however, the strength of the squad is reduced below 6 privates, duties are assigned to the remaining cannoneers as follows:

Distribution of duties.

Cannoneers retained.	G	1	2	3	4	5	6
Gunner and 5 cannoneers	G	1	2	......	3,4	5	6
Gunner and 4 cannoneers	G	1	......	......	2,3,4	5	6
Gunner and 3 cannoneers	G,1	......	......	......	2,3,4	5	6

1042. In action, if casualties become excessive, the service of one or more howitzers may be discontinued, and the cannoneers sent to assist at other pieces so as to have, if possible, a gunner and three men for the service of each piece.

1048. In order to accustom the personnel of the firing battery to replacing casualties and to serving the pieces with a reduced number of men, the captain frequently designates individuals who are to fall out. This training should not, however, be begun until the instruction of the personnel is well advanced.

CHAPTER VI.

SERVICE PRACTICE.

SECTION I.—DEFINITIONS.

1044. **Angle of departure**: The angle between the plane of site and the line of departure.

Angle of fall: The angle between the plane of site and the tangent to the trajectory at the point of fall.

Angle of incidence: The angle between the plane of the surface struck and the tangent to the trajectory at the point of impact.

Burst center, center of burst, or mean point of burst: The point about which the points of burst of several projectiles are evenly distributed.

Burst interval: The distance in the plane of site from the point of burst to the target.

Burst range: The distance from the muzzle of the gun to the point of burst.

Counter slope: A slope which descends toward the enemy and is wholly or partially hidden from him by the covering crest of the reverse slope.

Crest: The summit of a ridge.

Curved fire: Fire with low muzzle velocity, the elevation not exceeding 540 mils.

Danger space: The distance, in the plane of the slope considered, over which an object of a given height would be struck.

Deflection: The angle between two vertical planes containing one the line of sight, and the other the axis of the bore.

Deflection center. The point about which bursts in air or impact are evenly distributed in direction.

Direct fire: Fire with high muzzle velocity, the elevation not exceeding 360 mils.

Direct laying: Pointing the gun for direction and elevation by directing the line of sight upon the target.

Drift: The departure of the projectile from the plane of fire due to its rotation and to the resistance of the air.

Elevation: The angle between the plane of site and the axis of the bore when the gun is laid.

Height of burst: (1) The vertical angle between the plane of site and a right line joining the muzzle of the gun and the point of burst. (2) The ordinate of a point of burst.

Height of burst center: The point about which bursts in air are evenly distributed in height.

High angle fire: Fire with elevation exceeding 540 mils.

Indirect laying: Pointing the gun for direction by directing the line of sight upon an objective other than the target, and for elevation by the use of a quadrant or elevation level.

Jump: The angle between the line of departure and the axis of the bore before firing; hence, the difference between the elevation and the angle of departure.

Line of departure: The prolongation of the axis of the bore at the instant the projectile leaves the gun.

Line of sight: The right line passing through the sights and the target or the aiming point.

Mean height of burst: (1) The height of the burst center. (2) The average of several heights of bursts.

Mil: The unit of angular measure, one sixty-four-hundredth of a circle. The arc which subtends a mil at the center of a circle is, for practical purposes, equal to one one-thousandth o the radius. The arc and its tangent are nearly equal for angles not greater than 330 mils.

Military crest: The line nearest a crest from which all the ground toward the enemy may be seen and reached by fire.

Muzzle velocity: The velocity of the projectile at the instant it leaves the bore. Velocities are measured along the tangent to the trajectory at the point considered and are expressed in feet per second.

Normal corrector: The corrector setting which gives a normal height.

Normal height: The height of burst giving the maximum effect from a projectile.

Ordinate: The distance of a point of the trajectory from the plane of site. The maximum ordinate is the ordinate of the highest point of the trajectory.

Parallax: The angle at any point subtended by any given line.

Plane of fire: The vertical plane through the line of departure; also called *plane of departure*.

Plane of site: A plane containing the right line from the muzzle of the gun to the target, and a horizontal line perpendicular to the axis of the bore at the muzzle.

Point of burst: The point at which a projectile bursts in the air or at which it would have burst in the air had it not struck the ground.

Point of fall, of impact, or of graze: The point where the projectile strikes.

Probable error: The amount of error that, in a large number of occurrences, will be as often exceeded as not.

Quadrant angle of departure: The angle between a horizontal plane and the line of departure.

Quadrant elevation: The angle between a horizontal plane and the axis of the bore when the gun is laid.

Range: The distance from the muzzle of the gun to the target.

Range center, center of impact, or **mean point of fall**: The point about which the points of fall, reduced to the plane of site, are evenly distributed.

Range or burst center: The point about which bursts in air are evenly distributed in range.

Site: The angle between a horizontal plane and a right line joining the muzzle of the gun and the target; called also the *angle of position*. The origin of site scales is taken at 300.

Trajectory: The path described by the projectile in its flight.

Remaining velocity: The velocity of the projectile at any point of the trajectory.

Reverse slope: The slope which, from the direction of the enemy, is hidden by a ridge of which the slope is a part.

Terminal or striking velocity: The remaining velocity at the point of burst or point of fall.

Time of flight: The time in seconds required for the projectile to travel from the muzzle of the gun to any point of the trajectory—usually to the point of fall or of burst.

SECTION II.—THE TRAJECTORY.

1045. The relation between the elements of the trajectory is influenced by the muzzle velocity of the projectile, by the angle of departure, and as soon as the projectile has left the bore, by the force of gravity, the resistance of the air and the rotation of the projectile around its axis.

If the force of gravity, the resistance of the air, and the rotation of the projectile around its axis could be eliminated, the projectile would describe a straight line and its velocity would remain constant. If the projectile be supposed to be influenced only by its velocity, the angle of departure, and the force of gravity, it can easily be shown that it would describe a curve, the highest point of which would be the center of the trajectory, and that both halves of the trajectory would be identical in shape. But the resistance of the air acts to reduce the velocity of the projectile from the instant it leaves the muzzle, and consequently influences the path which it describes, so that in reality the highest point of the trajectory is nearer to the far end, and the two parts of the trajectory are unequal and unsymmetrical.

In order to force the projectile to travel along its trajectory with its point foremost, a rotary motion is imparted to it by the rifling in the gun.

1046. When the target and the gun are in the same horizontal plane, the proper elevation for the gun is the range-table elevation.

When they are not in the same horizontal plane, the proper elevation for the gun is the range-table elevation plus or minus the site. The site is additive if the target is higher than the gun, subtractive if it is lower.

1047. When direct laying is used, the site is automatically taken into account, as the line of sight is directed on the target. On the other hand, when the elevation is given by the quadrant it must be increased or diminished by the site, so as to bring the trajectory on the target.

1048. The remaining velocity decreases as the range increases.

1049. The time of flight increases more rapidly than the range.

1050. The drift increases more rapidly than the range. By increasing the deflection by the amount of drift for any range the axis of the bore may be pointed as far to the left of the target as the shot would drift to the right.

1051. The fuze of the shrapnel permits its use for either percussion or time fire. In time fire, under normal atmospheric conditions, the fuze should cause explosion at a determined burst interval.

1052. When the time train burns too slowly, low points of burst, bursts below the target, or explosions on impact are obtained. When it burns too quickly, high points of burst are obtained.

1053. When a shrapnel explodes in the air the bullets are expelled from the case to the front, their paths, taken collectively, assuming the general shape of a cone, called **the cone of dispersion**, the apex of which is the point of burst, the axis coinciding approximately with the continuation of the trajectory.

The angle between the two lines cut from the surface of the cone of dispersion by a plane passing through its axis is called **the angle of opening**.

The angle of opening depends upon the relation between the velocity of rotation and the remaining velocity.

Manipulation of the Trajectory in the Plane of Fire.

1054. In the course of firing, the captain will be constrained to utilize the relations existing between the elevation, the site, and the corrector, which are the following:

The location of the trajectory in the vertical plane depends upon the site and the elevation. It may be changed by changing one or the other of these elements, or the same location may be retained by making the proper changes of both in opposite senses.

A variation of the site affects the range the same as an equal variation of the elevation.

The height of burst under normal conditions depends only on the site and the corrector.

If the site only is varied, the point of burst is displaced in height, but not in range; if the corrector only is varied the point of burst is displaced at the same time in both height and range. Simultaneous and equal but opposite changes of site and corrector cause no change in height of burst, but the burst range changes.

The burst range depends only on the fuze setter range and corrector settings. It is increased or diminished by increasing or diminishing the fuze setter range or by lowering or raising the corrector.

The points of burst of two or more rounds are not coincident unless these three elements remain constant, or unless all three change at the same time by suitable amounts and in the proper relation.

The differences in range shown in the range tables as corresponding to given variations of elevation are measured in the plane of site. On slopes greater than the plane of site, such as a counter slope, the difference in ranges to points of fall will be less than that in the tables. On terrain inclined in the opposite sense, such as a reverse slope, the difference in ranges to points of fall will be greater than that in the tables.

SECTION III.—GENERAL PROVISIONS.

1055. To render effective assistance to other arms upon the battle field, field artillery must be able to deliver a timely and overpowering fire upon any designated part of the enemy's position.

1056. The battery is the fire unit.

1057. Those areas of the hostile position within which fire is to be delivered by particular artillery units are called **sectors.** They are usually described by reference to prominent points of the terrain, right lines to which, from the observing station of the commander of the artillery unit considered, limit the area assigned. Within, and sometimes outside, the sectors assigned, fire must be delivered upon objectives called **targets.**

1058. The tactical command of one or more fire units with a view of bringing their fire to bear upon a suitable position upon the proper targets at the appropriate time is called **fire direction.**

1059. The dispositions that must be made and the technical determinations of the data necessary before opening fire constitute **preparation of fire.**

1060. Conduct of fire consists in employing the technical means necessary to cause fire of the desired nature to be brought to bear upon the target.

1061. The officer charged with the conduct of fire must be the master of the fire of his guns. He must be able to turn the fire promptly upon any target at will and to regulate its intensity and distribution as circumstances require. The attainment of this condition requires on the part of the officer complete familiarity with the weapons at his disposal and skill and quick decision in their use, and on the part of the organization thorough knowledge of the matériel, uniform and reliable service of the piece, cooperation of all parts, and strict fire discipline.

1062. Accurate and skillful cooperation of several batteries under a single command is the foundation of proper fire direction.

1063. Owing to inaccuracies in the determination of f data, to the influence of weather conditions, to errors mad the service of the guns, and to imperfections in matériel ammunition, fire must be delivered and, on the basis of o vations, corrected to insure effectiveness upon the target. ing such fire effect is desirable. Fire of this nature is c **fire for adjustment.**

When fire has been thus adjusted it must be continued, with changed data, to secure effect. During such fire conti observation is necessary. Fire of this nature is called **fir effect.**

SECTION IV.—POSITIONS.

1064. Artillery may be posted for **immediate action, in o vation,** or **in readiness.**

When posted for **immediate action** the guns are unlim and fire is opened as promptly as possible upon the indi targets.

When posted **in observation** the guns are unlimbered an preparations made for opening fire at the desired moment the existing or expected targets.

When posted **in readiness** the guns are not unlimbered. are held under cover near a position for possible imme action, but so that they can be moved quickly to another loc if the development of the tactical situation so requires. the meantime the immediate tactical situation is studied, tions in the neighborhood for posting the guns to meet diff eventualities are selected, and preparations are made for pying the selected positions and for promptly opening fire the existing or expected targets.

1065. Positions are defined as **masked** or **in the open,** ac ing as they afford concealment from the hostile position or

When no concealment is afforded the guns are said to be in **the open.**

When concealment is afforded, the guns are said to be **under cover** or in a **masked position,** and the fire is referred to as **masked fire.**

The degree of concealment varies. Thus:

(*a*) If the guns are posted so that through the sights the hostile position can be seen over the mask, they are said to be **in the open.**

(*b*) If where a dismounted man can just see the hostile position over the mask, they are said to have **dismounted defilade.**

(*c*) If where a mounted man can just see the hostile position over the mask, to have **mounted defilade.**

(*d*) If so that the flash of the gun will be concealed from the hostile position, to have **flash defilade.**

Positions are described by the foregoing terms.

1066. The hostile position against which defilade is taken may be the target to be attacked; preferably, however, defilade is taken against the highest position from which enemy parties can effectually observe.

1067. A defilade of 4 yards is sufficient to conceal the flash of the gun by day. A defilade greater than this is still referred to, however, as **flash defilade.**

Complete concealment is obtained only in positions having flash defilade.

1068. The captain of a battery acting alone usually has great latitude in choosing the position for his battery.

In battalion the choice of a battery position is limited by the battalion commander, who must consider neighboring batteries and many other conditions.

1069. By whomever it may be chosen, the position of th guns should conform to certain conditions whose requireme are frequently contradictory.

First. The battery should be able to fulfill its tactical mi sion; that is, it must be able to fire effectively upon its targets.

Second. It should be as little exposed as possible to hostil observation or fire.

Third. The facilities for command of the battery should b such as will insure the rapidity of fire demanded by the tactic situation and the nature of the targets.

1070. Indirect laying permits the conduct of fire from a di tance. The difficulty of transforming information at the loc tion of the officers conducting fire for application at the gun increases more or less with the distance and direction of sep ration and with the difference of altitude. The difficulty transmission of information also increases with the distance.

Section V.—Duties of Officers.

1071. Due to the extensive use of cover brought about b the efficiency of modern firearms, the targets of artillery a certain to be concealed from view a greater part of the tim and likely, when visible, to remain so but a short time. T find out where the enemy is, to determine definitely the loc tion and nature of hostile bodies, and to secure the informatio which will enable the guns to open prompt and effective fi have hence become duties of the first importance. **Before th commencement of the action and through all its phases th** information must be sought. Preparation must be made on th tactical side for posting the guns where they will be mo effective, and on the technical side for securing the data whic will permit fire to be opened promptly on all the positions which the enemy is known or expected to occupy.

1072. The commander of the troops determines the object of the action, fixes the extent of Artillery support to be furnished the larger units, and indicates important objectives for special attack.

The distribution of objectives and the determination of the way in which the Artillery is to attack them are the province of the Artillery commander.

1073. At the beginning of the action the Artillery brigade commander, knowing the objective of the Infantry, what troops are designated to attack these objectives, and the degree of support for the different attacks, distributes the Artillery at his disposal so as best to accomplish the desired results. He designates the organizations that are to support a particular attack and those that are to be held in observation or in readiness to meet the developments of the action. He makes clear to his subordinates the mission that each is to accomplish. As the combat progresses he keeps himself informed of the progress of the different attack and if necessary modifies his initial orders. He keeps his subordinates informed, as far as possible, of the situation and of changes in the general plan.

1074. The regimental commander causes his unit to take position and assigns sectors to the battalions in accordance with the orders he has received. He keeps himself constantly informed as to the dispositions both of the enemy and of the troops with which his regiment is cooperating. He takes steps to insure an adequate supply of ammunition. In certain cases, as, for example, when it may be necessary to concentrate the fire of his entire regiment against a comparatively narrow front, the regimental commander may have to direct the fire in detail. In general, however, he indicates the portions of the e line upon which fire is to be delivered, leaving the details of fire direction to his battalion commanders.

1075. The battalion commander directs the fire by assigning targets to the batteries and by furnishing them such information and data as will tend to increase the efficiency of their fire. To this end he transmits to them such information concerning the nature of their targets, ranges, conformation of the ground in the vicinity of the objectives, etc., as may become available from maps, reports, and orders received, from his personal reconnoissances, or any other source.

The battalion commander must keep himself constantly informed as to the effect of the fire.

1076. The battalion commander designates targets and assures himself that they are identified. Technical details are ordinarily left to the battery commanders.

1077. Sudden changes in the tactical situation may cause the battalion commander to take under the fire of his batteries targets not originally assigned to his unit. He will at once report the fact to his immediate superior.

1078. Within the battalion changes of objectives are usually ordered by its commander and communicated to all batteries concerned, but a battery commander may order change of objective, on his own responsibility, for the support of troops in a critical situation, or when necessary for the close defense of his guns, reporting his action as soon as practicable to his immediate superior. As such cases usually necessitate fresh adjustment, involving loss of time, the targets should not be changed except in emergencies until the result sought against the former target have been fully attained.

1079. When communication is broken between a battery commander and his battalion commander the former will take over the duties of fire direction.

1080. It is the duty of all commanders to transmit to officers conducting fire all available information which would assist in adjusting the fire or in increasing its effect. It is the duty of all newly arriving units to seek information of this character from units already in action, and it is the duty of all officers having this information to furnish it.

1081. **Fire direction** is the function of battalion commanders, who exercise it in detail by assigning targets to particular batteries, and of higher Field Artillery commanders, who usually exercise it by assigning sectors to battalions.

1082. **Conduct of fire** is the function of battery commanders.

1083. In the general case the Field Artillery commanders assign duties to their subordinates, specifying clearly and as succinctly as possible the tasks to be accomplished by each; they exercise supervision over the supply and expenditure of ammunition, giving such special directions as may be necessary to insure the same being used to the best advantage to meet the requirements of the various phases of the action; they assist their subordinate commanders by keeping them supplied with all attainable information which will aid in the adjustment or employment of fire; but they refrain from interfering in the details of conduct of fire or the service of the guns, interposing only when it is perfectly obvious to them, after careful observation of the fire, that the target is misunderstood or that the desired results are not being attained.

1084. Cases may exceptionally arise where it will be necessary for the higher Field Artillery commanders to conduct the fire of a part of their commands. Suitable tactical dispositions should be sought to avoid such cases, which are most likely to occur in close country where targets visible to the higher commanders may not be visible from the stations of subordinate commanders.

1085. The higher Artillery commanders are concerned cially—

1. To procure by all possible means definite information the position of hostile bodies, or as to the positions liable occupied by them.

2. To select positions or areas to be occupied by the diff units of Artillery and to cause reconnoissance officers to d mine the necessary firing data for these positions.

3. To assign each unit its particular duty or task, designa when appropriate, those units for **immediate action** and tho take position **in observation** or **in readiness.**

4. To formulate clearly in their minds the terms or met which they will employ in the designation of objectives gets, aiming points, registration marks, etc.).

5. To provide each subordinate commander and to keep provided with all available information, technical and tac which will assist him in the performance of his duties.

For this purpose, to organize the service of information communication so that information as to positions and n ments of the enemy and of our own troops may, on the one be quickly obtained and, on the other, be quickly transmitt

6. To organize and maintain the service of ammunition other supplies.

1086. Battery commanders are concerned especially—

1. To select suitable observing stations for themselves to post auxiliary observing parties, if practicable, so that may assist in the observation of fire.

2. To examine the target assigned and endeavor to deter clearly is nature, its extent, and its relation to surrou objects.

3. To study the terrain in the neighborhood of the ta locate, if possible, any ravines, hollows, or obstructions

would hide the fall of projectiles, and decide whether it will be necessary or preferable to adjust the fire upon some particular part of the target rather than upon the whole front.

4. To measure the front to be attacked and decide upon the method of distributing the fire.

5. To decide upon the method of laying, selecting an aiming point if indirect laying is to be used.

6. To determine the initial firing data, if they have not been furnished by the battalion commander or reconnoissance officer or from other sources.

7. To decide whether the adjustment is to be by time or percussion fire, and whether by platoon or by battery.

1087. The executive establishes his station near the guns, in a location from which he can most readily exercise his functions and communicate with the station of the battery commander.

1088. The time available for the performance of the foregoing duties depends entirely upon the nature of the action. In some cases they must be performed with the utmost celerity; in others the opportunity is afforded for deliberate and complete preparation before opening fire. **Every effort must be made to reach the position in advance of the moment for action, and thus gain the opportunity to appreciate the situation and make the necessary dispositions for the prompt opening of effective fire.**

SECTION VI.—OBSERVING STATIONS.

1089. The officer conducting the fire should choose his observing station so that he can see all of his sector and as much as possible of the adjoining terrain.

To facilitate the transmission of orders and the proper exercise of command the station should be as near the guns as the conditions permit. This may often be accomplished by elevated observing stations, such as trees, buildings, etc specially prepared ladder or tower.

When the observer is in immediate proximity to the g is usually necessary for him to take post on their win flank in order that his view may not be cut off by du smoke and that his voice may carry more certainly.

1090. The commander of an isolated battery frequently wide latitude in the selection of his observing station the proximity of other batteries, the advantage of flash de and of withdrawing the guns from their mask to redu chance of their being reached by searching fire, and th pelling necessity of observation of the sector may impose tion remote from the guns. In such a case reliable con cation must be established and maintained.

1091. If the station is in immediate proximity to the or is apt to be subjected to the enemy's searching fire, s protection from hostile fire should, whenever possible, t vided for the observing officer.

1092. Battalion commanders should seek observing st from which they can both surely see the terrain assig their units and communicate quickly and certainly wit battery commanders without complicating the communi of the latter with their batteries. The most favorable sit is one near to and between two of the batteries whe stations of the major and two captains may be closely ciated.

1093. Auxiliary observers may frequently be used wi vantage at stations near the targets or at a considerab tance to a flank of the line of fire. Elevated stations ar ticularly favorable. In the selection of such stations the important requirements are a plain view of the target a adjoining area, cover from hostile discovery, and sure and swift communication with the stations to which they are auxiliary.

Observers close to the target should preferably be established from battery personnel. Except when a battery is acting alone, flank observers will ordinarily be supplied by the battalion commander. Flank observers who are intended to assist in adjustment of fire should be in visual communication with the unit from which they are sent out.

1094. Auxiliary observing stations are also established in captive balloons and in mobile aircraft.

SECTION VII.—COMMUNICATIONS.

Methods.

1095. The best means of communication is the voice, using the megaphone if necessary, but frequently communication must be by telephone, by buzzer, by signals, by relays of men for voice transmission, by courier. The whistle also may be used.

1096. Alternative means of communication should habitually be established.

1097. Each battery, each battalion headquarters, and each regimental headquarters is provided with suitable apparatus for signaling and for electrical communication.

The available matériel must be employed according to a flexible scheme, and each case must be solved according to the particular necessities.

1098. Frequently the higher commanders will find it convenient to post themselves near one or more of their subordinates and communicate with them by word of mouth or by couriers. The matériel and personnel thus freed from other use may be utilized in establishing communication with auxiliary observing stations, ammunition trains, or reconnaissance officers and scouts accompanying other troops.

Battery Communication.

1099. The battery signalers comprise a corporal, designated **telephone corporal**, and two privates designated as **operator No. 1** and **operator No. 2**.

1100. The telephone corporal is in immediate charge of and responsible for all the signal equipment of the battery.

He makes such tests and repairs as he may be authorized to make, and reports all trouble which he can not remedy to the captain personally at the first opportunity.

He is responsible that the kind of communication required is established quickly and effectively.

He reports to the captain when communication is established with the guns and with the battalion commander. Similarly he reports any break occurring in the line of communication.

He acts as operator at the battery station on the line to the battalion station.

When available he assists in relaying commands by voice.

1101. Whenever the battalion line is laid near a battery observing station the telephone corporal habitually establishes communication over it with the battalion station.

1102. Operator No. 1 assists in establishing the kind of communication required.

He reports to the executive when communication is established. Similarly he reports any break occurring.

He acts as operator at the station of the executive.

He is assisted by **scout No. 1**.

1103. Operator No. 2 assists in establishing the kind of communication required.

He reports to the telephone corporal or to the captain when communication is established. Similarly he reports any break occurring.

He acts as operator at the battery commander's station on the battery line.

1104. When signal or wire communication with the battalion station is unnecessary, the operators may be employed for communication with auxiliary observers, with scouts, or with other units.

Battalion Communication.

1105. Battalion communication is established and maintained by a sergeant major, a signal corporal, a signal private, an agent from each battery, and the battalion bugler.

1106. The sergeant major supervises the maintenance of, and is responsible for, all the battalion signal equipment.

During the reconnaissance of the position he receives the battalion commander's instructions as to the kind of communication required and supervises its establishment.

If communication by wire is to be established, he examines the ground, selects the route for the line to follow, and causes the reel cart to lay the wire.

He is in general charge of all messages received or sent by wire, signals, or agents at the battalion station.

He assists in sending and receiving messages.

1107. Whenever the regimental line is laid near a battalion observing station the battalion sergeant major habitually establishes communication over it with the regimental station.

1108. The signal corporal is in immediate charge of and responsible for all the signal equipment of the battalion.

He makes such tests and repairs as he may be authorized to make and reports all trouble which he can not remedy to the adjutant personally at the first opportunity.

Under the direction of the sergeant major he establishes the kind of communication required.

He reports to the adjutant or the battalion commander when communication is established with the batteries. Similarly, he reports any break occurring.

He acts as operator at the battalion station on the line to the batteries.

1109. The signal private assists the signal corporal in the maintenance of the signal equipment and the establishment of communication.

He reports to the adjutant or major the establishment of communication with the regimental station. Similarly, he reports any break occurring.

He acts as operator at the battalion station on the line to the regimental station.

When not otherwise engaged he acts as recorder for the signal corporal.

1110. Agents carry messages to the various elements of the command.

1111. The battalion bugler, when not otherwise engaged, assists the sergeant major at the battalion station.

1112. Signal equipment and personnel not required for signal or wire communication with the batteries may be employed for communication with auxiliary observers, with scouts, or with other units.

1113. The wire may usually be most conveniently and rapidly laid by commencing at the battalion station, because the reel must be taken there with the cart. But if time permits, the wire is preferably laid so that, at the completion of the task, the reel will be near the battalion station. Wire may thus be held immediately available for extension of the line.

Regimental Communication.

1114. Signal or wire communication between the regimental commander and his battalion commanders, and between the regimental commander and the next higher commander, is established in a manner similar to that in a battalion, corresponding individuals performing similar duties.

Brigade Communication.

1115. No special apparatus or operators for signal or wire communication are provided at brigade headquarters. The brigade commander gives such general instructions as may be necessary to insure the maximum utilization of the personnel and matériel available in the lower units.

When the Field Artillery brigade commander directs a regiment or battalion to furnish a certain line, as, for example, to connect the regiment with brigade headquarters, the designated unit furnishes such operators as may be required at brigade headquarters, as well as at other stations on the line to be established.

Laying the Wire.

1116. The battery telephone corporal attends to stretching the wire and setting up the stations in cases involving the use of the battery hand reels.

1117. The sergeant major ordinarily accompanies the reel to make sure that it follows the most appropriate route, to see that at the different stations the operators are ready and make proper connection to the line, and to give the line guard such special instructions as may be necessary to insure the proper placing and protection of the line.

1118. Every precaution must be taken to avoid betraying the position when laying the wire. To accomplish this it may frequently be desirable to cause the reel cart to follow a route considerably in rear of the line which the wire is to occupy and to carry the wire by hand to its proper position after the unreeling has been completed.

1119. It is essential that all wire be so laid as to be as far as possible out of the way of probable movements, either of field artillery, of other troops, or of individuals. The wire is stretched either before or after the posting of the guns, as may be most suitable in the particular case. Whenever practicable it is best to run the wire in front of the line of guns rather than in rear. When the line must be laid on ground which has to be crossed by teams in taking up the position it may be best to wait until the guns have been posted and until the teams have cleared the position before beginning to lay the wire.

1120. For effective wire communication good grounds at the instruments are essential. Moist earth should be sought. In dry earth the most favorable location is one near the roots of grass or brush. A satisfactory ground may be obtained through a rod driven into a growing tree.

Guarding the Line.

1121. It is the duty of all men, knowing the position of a wire and seeing it approached by others who are evidently unaware of its location, to give warning by calling "Wire."

1122. As a rule sufficient warning as to the location of a line pertaining to a battery can be given without its being necessary to detail a special line guard. When necessary, however, the executive details one or more men to patrol and guard the line.

1123. The line guard pertaining to a reel cart follows the reel when the wire is being laid, shifts the wire to the side of the road, and takes such other precautions as may be practicable for protecting the wire and minimizing its interference with traffic.

Often the wire may be suspended from trees or posts high enough to permit the passage of mounted men. At road crossings it may be covered with boards or earth.

After the wire is laid the line guard patrols the line, warning individuals who approach it of its location, and making repairs when necessary. The necessary men are detailed from the headquarters detachment or, if no members of such detachments are available at the time, they are temporarily detailed from the batteries.

To Use the Telephone.

1124. In speaking into the transmitter the head should be held in a natural position, the lips about an inch from the transmitter. The transmitter should be held with its face vertical and should be protected from the wind.

In a high wind good results may be obtained by pressing the transmitter against the throat on either side of the windpipe.

Use a moderate tone of voice and speak slowly and distinctly, being careful not to slur the words or syllables, but to enunciate clearly each sound.

Never shout or raise the pitch of the voice.

Never use the letter "O" for zero; when so used it is often mistaken for "four."

The digit "9" being often difficult to understand, the word **niner** may be substituted therefor.

If it is necessary to repeat, use more care as to distinctness, but do not raise the voice. A single number not unders may be accentuated by counting up to it and emphasizing it. Thus, if the figure 4 is not understood, say, **FOUR**: one, two, three, **FOUR**.

In receiving observe the following rules:

1. Keep the mind on the message; a person can not receive correctly when he is thinking of something else.
2. Keep the receiver close to the ear.
3. Do not interrupt the sender unless absolutely necessary.
4. Caution the sender when he is speaking too loudly, not loudly enough, or too rapidly.

1125. In the service buzzer one good battery placed in position next to the hinge of the battery door will operate the telephone element, while two batteries are needed for buzzer communication.

When no serviceable tungsten batteries, type A, are available, four dry cells of any type may be utilized, as follows: Remove the old tungsten batteries; connect the four dry cells in series; attach one end cell lead to lug P of induction coil, the other end cell lead to the horizontal bar alongside the coil. This operates the buzzer element.

The telephone is operated by connecting the binding post T to the connection between the two middle cells.

Use of the Buzzer.

1126. Transmission by buzzer is more accurate than by telephone, but it is slower. It is particularly appropriate when insulated wire has been injured or when bare wire only is available. Its use may be necessitated by noise and induction rendering the telephone unreliable. Efficiency of buzzer service requires a high state of instruction in the maintenance and use of the instrument.

Tests.

1127. Faults in the line are most surely discovered by cutting in at several points with an extra instrument. They are due to grounding or to breaks.

A bad ground of the line near the instrument is indicated by a weakening of the buzzer note when the instrument is connected to the line, and frequently by a noisy receiver.

A partial ground of the line is indicated by weakness or complete failure of telephone transmission, although buzzer transmission is possible.

An opening or break in the line is indicated by complete failure of telephone transmission, although buzzer transmission may still be possible.

1128. Instrumental tests are described in paragraphs 683 and 684.

Signaling.

1129. Semaphore signaling is the most rapid visual method.

1130. Under favorable conditions semaphore signals with the arms can be read up to 600 yards. In a clear atmosphere semaphore signaling with the flags can be read without field glasses up to 1,200 yards; with glasses, up to 2,000 yards. Special attention must be given to conditions of light and background and to defilade from the enemy.

Voice Relay.

1131. A chain of men for relaying by voice may become necessary. But the number of men between the sender and receiver should not exceed two, as opportunities for error are th rapidly increased. In any case such communication will b slow, and it will be effective only if the men have been traine to the duty.

Couriers.

1132. Messages by courier should, in general, be written. I sent orally, they should be of the simplest character, usuall involving only a single statement.

Whistle.

1133. A long blast of the whistle denotes **cease firing.** It used when the command is likely to be unheard or to be delaye in reaching the guns. It must not be used when there is a possibility of its being heard by batteries other than the o intended.

Aircraft.

1134. Communication from mobile aircraft is reliable on when radiotelegraphy is used. In the absence of such mea it will be necessary to use written or phonographic me dropped to the ground; to the notes of a high-pitched horn short distances; to colored lights, as from a Very pistol; mechanically projected dots, dashes, or streamers of blac powder; to certain evolutions of the aircraft; or to other pr arranged signals.

Signaling to mobile aircraft is reliable by means of stri of white cloth, about 20 yards long and 2 yards wide, fastene to the ground in conventional geometrical figures.

1135. Communication to and from captive balloons and ki should be by wire.

SECTION VIII.—PREPARATION OF FIRE

1136. By skillful preparation of fire the time required to secure adjustment may be greatly abridged, and the ability may be gained to strike a vulnerable enemy by surprise with fire which is from the outset effective.

1137. In the preparation of fire the captain usually requires assistance. This is obtained from members of the special details consisting of the instrument detail, the signal detail, and the scout detail.

The instrument detail consists of one instrument sergeant, one range-finder operator (generally a first-class private), and one horse holder.

The signal detail consists of one telephone corporal and two operators, designated as operator No. 1 and operator No. 2.

The scout detail consists of one corporal and one second-class private in peace and of two corporals in war.

1138. The instrument sergeant is in general charge of the instruments and equipment used by the special details.

He is informed at the earliest possible moment as to the situation, the sector assigned, the location of hostile and friendly troops, the reference point, the target, the position of the guns, and the aiming point.

He sets up the telescope and the aiming circle, operates the latter, and calculates firing data.

He keeps a record of the firing and assists the captain in observing the fire and studying the terrain, and in collecting, recording, and transmitting data.

1139. The range finder is responsible for the condition, care, and operation of the range-finding instrument.

He receives the same information as the instrument ser and finds for him the ranges required.

He assists the captain in observation of the fire, the e and the terrain.

1140. Scout No. 2 is informed as early as possible as t situation, the sector assigned, the location of hostile and fri troops, and the target.

He prepares such place or panoramic sketches as ma directed.

He observes the sector, especially the target, reporting ch in its formation, appearance, and movement, and any upon it.

He may be assigned to particular duties, such as to obs tion regarding the security of the battery, to observati friendly troops or of hostile bodies other than the targ assistance of other members of the detail.

1141. Other members of the battery commander's detai otherwise engaged may be assigned to duties in connection preparation of fire and its conduct.

1142. Whenever a position is occupied, all practicable will be taken to provide protection for the personnel addit to that afforded by the matériel, and shallow trenches w prepared to facilitate shifting the trails.

1143. The data that must usually be communicated t firing battery before the pieces can be fired are:

1. The aiming point or the target.
2. The deflection.
3. The deflection difference.
4. The site.
5. The kind of projectile.

6. The method of fire.
7. The zone (if other than zone 3).
8. The range.

Designation of Objectives.

1144. Objectives must be designated in a prompt, concise, and unmistakable manner. Officers must exercise themselves in describing objectives of all kinds, in all available forms of terrain, and must accustom those under them to the terms and methods employed in the description. Practice of this character should habitually form a part of firing instruction, and should also be included in the instruction of scouts and agents.

1145. Targets and aiming points are most clearly designated by word of mouth and to a person standing near by. On the occupation of a position the aiming point and the expected targets should, as far as practicable, be thus pointed out to the officer commanding the guns.

1146. If targets are distinct and clearly defined, they may be designated by name, as, for example, "The battery on hill 240," "Cavalry to the right front," etc. If a target is indistinct, poorly defined, or masked, then an area may be designated for attack, the nature of the target being invariably given.

1147. In designating objectives (targets, aiming points, registration marks, areas) the following procedure is appropriate, especially when the objective is not conspicuous or readily recognized:

Define the **relative position** of the objective by giving the approximate direction and distance of the objective and its location with respect to a prominent feature of the landscape as a **reference point**. Then give its important **characteristics**, such

as its nature, shape, and color. Sometimes the site of a
tive will simplify its designation.

1148. A reference point should, if practicable, be wit
sector assigned for attack, preferably near its center.

1149. Directions may be indicated by pointing; by the
military terms, such as to our left front; by the use of
nary hour marks on an artificial horizontal clockface the
of which is at the position of the speaker, and the 12
mark directly to the front of the position or at a reference
by the similar use of a vertical clockface whose cente
sumed to be at a reference point; by the points of the c

1150. The location of an objective may sometimes be f
coordinates.

1151. If the objective is in itself inconspicuous, it is
best to designate first the most prominent object in its
direction, then to give the angular distance between thi
ence point and the real objective, and then to give the d
to and description of the latter.

The usual method of procedure is as follows:

1. Indicate the general direction of the objective.
2. Designate the most prominent object in the directio
cated.
3. State the angular distance from this auxiliary objec
objective.
4. Characterize the objective.

Thus:

1. At 2 o'clock horizontal.
2. At 3,000 yards a large stone house, square, two
with a cupola on top.
3. Five hundred mils to the right of the cupola.
4. At 2,500 yards a light battery in position in rear
large orchard.

Or:

1. Northwest.
2. At 5,000 yards two symmetrical hills of the same height.
3. The left peak the reference point.
4. At 7 o'clock vertically, a field of brown weeds.
5. In that field, a machine-gun battery.

Or:

1. The lone tree on Artillery Ridge.
2. Two hundred yards south and four hundred yards west, a bare stretch of road.
3. Beyond the road, machine guns.

1152. If it is necessary to designate objectives to a person at a distance, it is important to remember that objects often present very different appearances if viewed from widely separated positions. For this reason it is desirable to select as reference points natural features having geographical names, or objects having no similarity to others near by, or features having a uniform outline, and hence presenting the same appearance from whatever angle they are viewed. If a courier is used to transmit such information, he is required to keep the objective in view as much as possible while passing from one station to the other.

1153. The designation of objectives may be greatly facilitated by the use of maps or by causing a position or place sketch of the terrain to be prepared and copies to be furnished the different subordinate commanders concerned. On such a sketch important landmarks and military objectives should be named or numbered for ready reference.

Panoramic sketches may be used in a similar manner, but when individuals using such a sketch for identification are widely separated, allowance must be made for difference in of view.

1154. Maps ruled into small rectangles that may be readily described by reference to horizontal and vertical notations on the margins are highly useful in the designation of objectives and areas.

Parallax.

1155. The parallax of an objective is the angle at a point of the objective subtended by a platoon front, 20 yards, at any place. Its value in mils is quickly calculated by dividing 20 by the number of thousands of yards from the place in question to the objective. Thus, the distance to an objective being 2,800 yards, its parallax is 7, fractions less than .5 being disregarded.

In calculating parallax it is sufficiently exact in the usual case to take as the divisor the whole number representing the number of thousands of yards in range; thus, 3 instead of 2.8 in the example given.

1156. The parallax of an objective is greatest when the objective lies on the normal to the middle of the platoon front considered. As the direction of the objective departs from this normal the parallax decreases until it becomes zero, when the objective is on the line of the platoon front prolonged. This is known as the change of parallax due to obliquity.

1157. The correction for obliquity may be determined with sufficient accuracy by multiplying the parallax, obtained through assuming the objective to be on the normal to the platoon front considered, by .9, .7, .4, and 0.0, when the angular distance of the objective from the normal is 400, 800, 1,200, and 1,600 mils, respectively. By interpolation the multipliers for other obliquities may be obtained.

1158. The parallax of a target is always positive. The parallax of an aiming point in front of the line of guns is positive, of one in rear negative.

Aiming Points.

1159. The selection of suitable aiming points for indirect laying calls for special attention. The best aiming points are:

1. Continuously visible through the panoramic sight of each gun.
2. Easily designated and identified.
3. At a considerable distance from the guns.
4. Of narrow width and sharp definition.
5. Near the normal to the line of guns or near the line of the guns prolonged.

It will frequently be impracticable to select an aiming point fulfilling all these conditions.

1160. The use of the same aiming point by all of the guns of a fire unit simplifies both fire direction and conduct of fire. When time is available before the guns come up it is best to go to the point where each gun is to be placed and make sure that the aiming point will be visible through the sight from that point. But a common aiming point is not indispensable.

1161. Some object which quickly attracts the eye should be selected, and, if possible, it should be the only object of its kind in the vicinity, so that doubt, hesitation, and mistakes may not arise either in the designation of the aiming point or in finding it quickly after looking away. Inconspicuous aiming points should be avoided.

1162. Although refinements in calculation of parallax are uncalled for, errors in its computation should be minimized by the selection of distant aiming points. Usually points more than 2,000 yards distant will be found most suitable.

1163. Narrowness and sharp definition in an aiming point make uniformity of laying more certain. If a broad aiming point must be chosen, the part of it to be used must b nated. If a tree, its trunk may be designated; if a rock, a certain edge; if a building, a certain chimney, gable.

1164. The rate of change in the value of the paralla 400 mils of the position of its maximum value, and it value within 400 mils of the position of its minimu are so small that for aiming points within these angles t lax need not be corrected. For other positions, the must be corrected for obliquity. Aiming points should b if possible, to reduce calculations.

1165. A point in rear of the guns is preferable to one because the top shield does not interfere with vision.

A point on a flank is appropriate when at a greater than 1,000 yards and when enough to the rear to pre being obscured by any of the matériel or personnel. At distances the recoil of the gun carriages materially cha parallax, thus shifting the sheaf of fire and causing ir ties of distribution.

1166. When artificial aiming points must be establish the guns, the best direction for a common one is directly of the center of the line of guns. To reduce the effect upon parallax a separate one may be placed directly in each gun.

1167. If the distant aiming point is apt to be obsc mist or smoke, then provision must be made for a se aiming point. The guns having been oriented on the t means of the distant aiming point, the sights may, whe sary, be turned upon the new aiming point and the latt in subsequent fire.

Firing Over a Mask.

68. The captain of a battery acting alone usually has great
ıde in choosing the position for his battery.
battalion the choice of a battery position is limited by the
lion commander, who must consider neighboring batteries
nany other conditions.

69. Practical use of the battery commander's ruler is made
termining whether it is possible to fire from a given position
intervening obstacles at a given target. The site of the
t, the height (or site) of the obstacle in mils, and the
s of target and obstacle in yards are first measured. The
t of trajectory in mils at the obstacle is then determined
he given range as follows:
ıce the number corresponding to the site of target opposite
umber on the range scale corresponding to the range to the
cle. Now read opposite the number on the range scale
sponding to the range to the target the height of trajectory
e obstacle. If the height of trajectory is greater than the
ıt of the obstacle in mils, the projectile will clear.
r example:

Site of target=285 (or —15).
Site of obstacle=520 (+220).
Range of target=2,800 yards.
Range of obstacle=200 yards.

70. Using the third or outer zone and setting 15 on the
ctory scale opposite 200 on the range scale brings 163 on the
ctory scale opposite 2,800 on the range scale; which means
the height of zone 3 trajectory at 200 yards is 163 mils.
ıe height of the obstacle is 220 mils, projectiles fired with
3 charges would not clear it.

1171. It may, however, be possible to use the second or middle zone in firing; setting 15 on the trajectory scale opposite 200 on the range scale brings 380 on the trajectory scale opposite 2,800 on the range scale, which means that the height of zone 2 trajectory at 200 yards is 380 mils. As the height of the obstacle is 220 mils, projectiles fired with zone 2 charges will clear it. As zone 1 has a trajectory of greater curvature than zone 2, projectiles fired with zone 1 charges will likewise clear the mask.

To Determine at the Firing Battery if Fire Will Clear the Mask.

1172. The executive causes any piece in the battery to be laid for direct fire on the highest point of the mask at the minimum estimated or measured range to the mask, using the range scale of the zone in which it is intended to fire. This marks the minimum elevation of the piece for clearing the mask with that particular zone, and any data which causes the muzzle to be depressed below this elevation will not permit clearance of the mask. If the pieces are not on the same level, the test should preferably be applied to the piece having the lowest site.

1173. If a permanent file mark be made on the sight lever where it bears against the rocker, such mark can be used as an index and a pencil or chalk mark made on the rocker which will indicate the minimum allowable elevation of the piece for any particular mask and zone. Any data for this zone which causes depression of the muzzle below the minimum thus recorded may throw the projectile into the mask.

1174. If the zone to be used has not been announced, marks for the minimum elevation for all three zones may be quickly made and labeled on the rocker and wiped off when the position is abandoned.

1175. If the line of sight along the lower element of the bore of the howitzer clears the mask by 15 mils or more when the piece is accurately laid, the projectile will clear the mask for that laying if the mask is very close to the firing battery.

1176. Whatever may have been the process employed for determining the position of the pieces with reference to the mask, the possibility of firing will always be verified as soon as the pieces are in position by measuring the minimum range at which each piece will clear the crest. The minimum range for firing with all the battery is the greatest of the minimum ranges announced for the several pieces. It is the duty of the executive to forsee and prevent any firing into a mask which would explode the projectile.

Measurement of Angles.

1177. Angles may be measured in mils by means of the telescope, the aiming circle, the ruler, the scale in the field glass or its known field of view, or by handbreadths.

The telescope and the aiming circle are instruments of precision. The graduated field glass affords means of measuring angles accurately. When neither the telescope nor aiming circle is available, or when time does not admit of their being set up, use may be made of the less reliable means, practice with which will insure considerable accuracy.

1178. For preliminary practice, horizontal and vertical scales of mils should be laid off on any convenient vertical surface, using an instrument of precision.

As the ruler is already graduated the distance at which it should be held from the eye so that its graduations will co corresponding spaces on the scales must be determined by trial. Usually this distance is then fixed by tying the ruler cord to the clothing or by knotting it and holding the knot in the teeth.

When the hand is used for angular measurements, its distance from the eye should be such as may be assumed naturally and uniformly and maintained without fatigue. The portions of the scales then covered by different parts of the hand can be determined and memorized.

The width of the field of view of the field glass can be determined similarly and quite accurately divided by eye into halves, quarters, and eighths.

In making the above calibrations the operator must stand at the position of the instrument used in establishing the scales.

1179. For measuring by handbreadths, each individual will obtain the best results by predetermining, according to the methods just described, the value in mils of certain parts of the hand.

Average values are given below, it being presumed that the hand is held vertically, palm outward, arm fully extended to the front:

	Mils.
Width of first finger at second joint	40
Width of second finger at second joint	40
Width of third finger at second joint	35
Width of little finger at second joint	30
Width of first, second, and third fingers at second joint	115
Width of first, second, third, and little fingers at second joint	150
Width of thumb	40

1180. Repeated practice should be had on varied terrain in measuring both horizontal and vertical angles with the field glass, the ruler, and the hand, the results being checked by accurate instrumental measurements.

1181. Frequently the terrain presents features that make possible the construction of rough vertical and horizontal scales, whose origin is at an objective, which will serve to measure angles that must be noted during firing.

1182. Errors of measurement and calculation of angles and the time required increase with the angles, particularly if the rougher methods are used. It is important, therefore, to reduce large angles as much as possible by resort to various expedients.

For example, an assistant may sight across the face of the object glasses of the field glass upon the aiming point or target. The observer may then select an auxiliary point on a right line perpendicular to the line to the aiming point or target. An angle that must be measured may thus be reduced by as much as 1,600 mils.

Or the line to an aiming point or target may be fixed with any two convenient objects, and the observer by placing himself on this line may avoid the measurement of as much as 3,200 mils.

Deflection.

1183. To overcome the effect of drift a correction in deflection may be necessary. With a little experience it may be readily estimated. It is always additive. The correction for wind is negligible.

1184. The following rough rules may be of assistance in correcting for drift.

Zone 1: Increase the deflection by 15 mils for each thousand yards of range (1.5 mils per hundred yards).

Zone 2: Increase the deflection by 8 mils for each thousand yards of range.

Zone 3: Increase the deflection by 4 mils for each thousand yards of range up to 4,000 yards and thereafter by 6 mils for each 1,000 yards of range over 4,000 yards. Thus:

Mils.
Range 3,500 yards, correction=3.5×4=14
Range 5,500 yards, correction= 4×4=16
1.5×6= 9
—
=25

1185. When direct laying is to be used the initial deflection may be fully determined by the foregoing rules.

1186. When indirect laying is to be employed there must also be determined the deflection setting which will cause each piece to be directed upon its target when its line of sight is directed upon the aiming point.

In unfavorable country it may sometimes require considerable ingenuity to direct the guns upon the target. The basis of the method usually employed is to select a common aiming point and to determine the deflection which will cause one of the pieces when laid on the aiming point to be pointed in the required direction. Such a piece is called the **directing piece.** The corrections for drift is added to the deflection of the directing piece. A correction is also determined which, applied in arithmetical progression to the deflection of the directing piece, will give for each of the other pieces the deflection necessary to bring its line of fire in the appropriate direction. This correction is called the **deflection difference.**

Deflection Difference.

1187. The principles involved in the determination of the deflection difference are best explained by assuming the target to be visible from the guns. Elementary instruction is best conducted, moreover, with the guns placed so that this will be the case, as a check may then be had on the computations made.

1188. If the guns of a battery at normal or other equal intervals are, with zero deflection, laid accurately upon the same part of a target—for example, its right edge—and the lines of sight are then all directed upon a common aiming point, the deflection readings will be found to increase or decrease from right to left by a common difference. This common difference in deflection is termed the **convergence difference.** It is the deflection difference necessary to produce converging fire, being positive if the deflections increase from right to left, negative if they decrease.

1189. The convergence difference may thus be measured directly if the guns are in position and the target can be seen through the sights. But the data should, in the general case, be obtained before the guns come up. Moreover, when indirect laying is to be employed the target is not usually visible from the guns. Direct measurement of the convergence difference is not then feasible in the usual case. By computation its value may be readily determined as follows:

(*a*) Determine the parallax of the aiming point and the parallax of the target.

(*b*) The convergence difference is equal to the parallax of the aiming point diminished algebraically by the parallax of the target. It is additive if this algebraic difference is positive, subtractive if it is negative.

1190. Assuming the guns to be still converged upon the right edge of the target, their fire may now be evenly distributed over the whole front of the target if we retain the same aiming point for all the pieces and the same deflection for the right piece but increase the deflection of each of the other pieces by an amount necessary to cause its line of fire to be directed upon its appropriate part of the target. The common difference in deflection necessary to effect this distribution is termed the **distribution difference.** Its value is obtained by dividing the front of the target, expressed in mils, by one less than the number of guns in the unit firing. It is always additive, provided the right gun is directed upon the right section of the target, and the difference is applied in arithmetical progression to the deflection of the right piece to determine the deflection of the other pieces in order from right to left.

1191. The algebraic sum of the convergence difference and the distribution difference is the **deflection difference.** If converging fire is to be used, the distribution difference is zero and the deflection difference is therefore equal to the convergence difference.

1192. The following nomenclature is used to designate the terms referred to above:

DD	Deflection difference.
CD	Convergence difference.
F	Front of target in mils.
P	Parallax of aiming point.
T	Parallax of target.
X	Number of guns in unit firing.

1193. The relations brought out in the foregoing discussion may be expressed as follows:

Rule I: The convergence difference is equal to the parallax of the aiming point diminished algebraically by the parallax of the target; or, CD=P—T.

Rule II: For converging fire the deflection difference is equal to the convergence difference; or, DD=P—T.

Rule III: For distributed fire the deflection difference is equal to the convergence difference increased algebraically by the distribution difference; or, $DD=P-T+\frac{F}{X-1}$

A special case of distributed fire is parallel fire. If the lines of fire are parallel they are directed upon points just a platoon front apart. Therefore, in the last equation, $\frac{F}{X-1}=T$ and $DD=P$. Hence we have

Rule IV: For parallel fire the deflection difference is equal to the parallax of the aiming point; or, $DD=P$.

1194. Rule IV affords a quick and ready means of distributing fire, since, to determine the deflection difference, an estimate of the distance to the aiming point and a computation of its parallax are all that is necessary.

1195. The foregoing rules afford a method of determining the deflection difference necessary to produce either converging, parallel, or distributed fire. If the pieces have a common aiming point and any piece is given a deflection which will cause its line of fire to be directed upon its appropriate section of the target, the desired convergence or distribution may be secured by giving the other pieces the deflection of this directing piece increased (or diminished) by as many times the deflection difference as there are platoon fronts between it and the piece considered **(960)**.

The Deflection of the Directing Piece.

1196. If it is possible to point the directing piece upon its target by looking through the sight, or by occupying an elevated position in rear and looking over the line of metal, then its deflection from an aiming point may be measured. Or, if an observer posted near the position of the directing piece can see the target, he may measure the angle in mils between the aiming point and the target, and this may be taken as the deflection. By taking post on a tower or ladder, by climbing a tree etc., the target may sometimes be seen from near the gun.

Or, two men may be posted between the gun and the target so that one can be seen from the gun. The one nearest the crest must see the other and the gun. The one nearest the gun must see the other and the target. By directing one another, these men can establish the line from the gun to the target.

But if the observer must be at a considerable distance from the guns, then the deflection of the directing piece must be secured by measuring at the observing station the angle from aiming point to target and transforming this angle for use at the guns.

1197. This transformation may be effected (*a*) by the parallax method; (*b*) by the parallel method.

The parallax method is used to best advantage when the observing station is in prolongation of the line of guns and not more than 400 or 500 yards away. It is an extremely quick method, the necessary computations being readily made mentally after facility has been gained.

1198. (*a*) **The parallax method:** To illustrate this method, let it be assumed that the observing station is on the right flank of the guns, in prolongation of their front, and at a distance of *n* platoon fronts from the right piece.

At the observing station the Angle A is measured from the aiming point to the right section of the target. This angle may be considered as the deflection necessary to cause an imaginary piece at the observing station to be directed upon the right section of the target; the actual directing piece, platoon fronts away, may be converged upon the same part of the target by increasing (or diminishing) the deflection of the imaginary piece by n times the convergence difference. The process is then altogether similar to that before explained for causing convergence in an established line of guns. We have then

Rule V: The deflection of the directing piece is equal to the angle from aiming point to target, as measured at the observing station, increased algebraically by as many times the convergence difference as there are platoon fronts in the interval between observing station and directing piece; or, $D=A+n(P-T)$.

If the observing station is on the right flank, n is positive in the foregoing equation; if it is on the left flank, negative.

1199. If the observing station is not on the prolongation of the line of guns, but is in advance of or rear of that line, the interval between observing station and directing piece must be measured perpendicularly to the line joining that piece and the target.

In the latter case the data secured will probably be only approximately correct: but the error in direction should not be great, and errors both in direction and distribution should be readily corrected by subsequent observation.

1200. The parallax method thus outlined gives great facility in transforming the deflection, not only from an observing station to a battery, but from battery to battery along a line of guns having a common aiming point. A great variety of special cases will be met in practice, but if the possibilities of the method are fully grasped some adaptation will usually afford a solution. By constant practice in the solution of all sorts of cases facility in the use of the method is to be obtained. The great advantage of the method is that it permits a rough approximation of the direction from gun to ta be quickly furnished. The approximation should be close to permit the first salvo to be observed; errors may quickly recognized and corrected.

1201. (*b*) **The parallel method:** Points may be qui lected, by estimation, in the direction of the aiming pc the target such that lines from the observing station will be approximately parallel to lines from the gun aiming point and the target. The included angle will deflection.

Or, the interval in yards from the observing statior line from the gun to the aiming point is measured mated. The angle at the aiming point subtended by this is computed and laid off on the side of the aiming point from the gun. An auxiliary point is there noted on the Similarly, the angle at the target subtended by the from the observing station to the line of fire is determi laid off on the side of the target farthest from the gun; auxiliary point is noted. The angle between lines t auxiliary points will be the deflection.

For example: The observing station is 100 yards to of the directing gun, the aiming point is 4,000 yards to th and the distance to the target is 2,500 yards. One 1 yards at 4,000 yards corresponds to 25 mils and 100 y 2,500 yards corresponds to 40 mils. Starting at a point to the left of the aiming point, measure to a point to the left of the target. This angle is the deflection directing piece. If the aiming point is very distant and placement from the gun is not great, the correction at t ing point may be disregarded.

1202. The special advantage of an aiming point com all the guns is that the officer conducting the fire may th simply calculate and establish the direction and distribution of his fire.

1203. If an aiming point visible from all the guns and from the observing station can not be found, then some expedient must be devised for directing the guns upon their targets. The following are given as examples of such expedients:

Example 1: The guns are in a depression and all view of the surrounding country is cut off. No natural aiming points are available. The battery commander, mounted on an observing tower, can see the target provided his tower is placed in rear of the third piece.

Solution.—The captain places his tower in rear of the third piece and, looking over the line of metal, directs the gun upon its appropriate part of the target.

He causes the gunner of the third piece to turn his panoramic sight upon the centers of the rammer staffs held vertically at the sights of each of the other pieces in turn and to read off the corresponding deflections. For pieces to the right of the third piece this deflection is increased 3,200; for pieces to the left it is diminished by 3,200. The resulting deflections are in each case set off on the sights of the respective pieces, and they are then laid, using the sight of the third piece as an aiming point. Parallelism of the lines of fire is thus secured.

The deflection of each piece may then be measured from an artificial aiming point.

Example 2: Suitable aiming points can be seen from the guns, but none of them are visible from the observing station, which, on account of the lay of the ground, must be placed about 400 yards to the flank of the guns.

Solution.—The battery commander decides to designate his telescope as a temporary aiming point. He determines the deflection of the directing piece as follows:

(*a*) Sets the telescope at 3,200, directs it upon the sight directing piece, and clamps the lower limb; unclamps the limb, directs the telescope on the target, and reads the ang

(*b*) Measures or estimates the interval in yards betwee scope and gun, divides this amount by the number of thou of yards in range to target, and thus procures the angle i at the target subtended by the interval between telescop gun.

(*c*) Adds this angle to the angle measured by the telesc the telescope is on the left of the guns, subtracts it if the scope is on the right. The result is the deflection to be us the directing piece, the telescope being the aiming point.

Setting off this angle on the sight of the directing piec using the telescope as an aiming point, the piece is laid o target. The direction of this piece may then be referred t suitable aiming point. By computing the deflection diffe in the usual way, the deflection to be given the other may then be determined.

1204. The captain may have to occupy an observing such that the data for computation can not be obtained.

Example: The executive has established the sheaf of f the general direction of the center of the sector assigned.

Solution.—The captain causes a single round to be fired one of his interior pieces and corrects the deflection in a ance with the observed result.

1204½. The target can not be seen from the pieces; the can not be seen from the observing station; there is no a point that can be seen from both observing station and an of the pieces.

Solution.—At the observing station, by means of a mag compass, locate an aiming point on the magnetic mer **through** the station measure the deflection from this poi the target and correct it for the displacement from the directing gun.

Similarly, establish the magnetic meridian through the sight of the directing piece, and lay this piece with the announced deflection.

Example:

Aiming point, the magnetic north (south).

Deflection, 1420.

The other pieces are laid by the methods previously explained.

A method which may be employed when all others fail is as follows: Run a **random line** from the directing piece in the general direction of the target until the mask is cleared; the error in the direction of this line is measured as soon as a point is reached from which the target can be seen, and the direction of the random line is corrected accordingly. The directing gun is then laid along the corrected random line and the other pieces are laid by the methods previously explained.

1205. The situation may be such that the pieces must be scattered at irregular intervals and without regard to alignment. The sheaf may be formed by the method described in paragraph **968.**

1206. When battery salvos are used, the second (third) piece should be taken as the directing piece and its deflection calculated for the right (left) of the target.

When platoon salvos are used, the first (fourth) piece should be the directing piece, its deflection that for the right (left) of the target.

1207. When the deflection and deflection difference have been calculated under conditions exceptionally favorable to accurate results the computed data should be used. Otherwise the initial deflection or intial shift is best announced as the multiple of 10 nearest to the determined value; and, except against very narrow targets, the intial deflection difference as t tiple of 5 nearest to a value determined by increasi braically by 10 the parallax of the aiming point.

Site.

1208. The correct determination of the site is impo the resultant saving of time and ammunition and in the tion of effect during fire for adjustment.

If the target is visible from the position of the guns, may be measured there. If the target is not visible f position of the guns, the site may be measured at the ol station and transformed, if necessary, for use at the gu

In open country the site may often be estimated with s accuracy by referring the site of the target to a distant the site of which is ordinarily 300.

1209. If the observing station and the guns are at mately the same level, and at approximately the same from the target, the angle measured at the observing st used without change at the guns.

1210. If the observing station is near the guns, but a ferent level, the angle measured at the observing statio rected, as follows: Estimate the difference of level in y tween observing station and guns; convert this differe mils by dividing the number of thousands of yards in r target and apply the result with the proper sign as a co to the site of the target as measured at the observing st

Example:

Site measured at observing station............... = 32
Estimated height of observing station above guns.= 3
Range of target (measured or estimated)........=3, 30

$$\text{Correction} = +\frac{30}{3} = +10 \text{ mils}$$

Site at guns=320+10=330 mils.

1211. If the distances to the target from the observing station and the guns materially differ, the angle measured at the observing station is corrected as follows: Determine the difference of level in yards between observing station and guns (Lg) and between observing station and target (Lt) by measuring the difference of level in mils, and converting this difference into yards by multiplying it by the number of thousands of yards in the distance from observing station to gun or target. Determine the difference of level in yards between gun and target by taking the sum of the foregoing differences if the observing station is at a level intermediate between the gun and target, by taking their difference if the observing station is above or below both the gun and target. The result is affected with a positive sign if the gun is below the target, with a negative sign if the gun is above the target; and it is then converted into mils by dividing by the number of thousands of yards in range. Applying this correction to 300 with the proper sign, the site at the gun is obtained.

The operations to be performed in effecting this transformation are set forth in detail in the Field Artillery Data Book.

Example:

Difference of level between observing station and gun, in mils.................(Sg) = —50

Difference of level between observing station and target, in mils.................(St) = +10

Distance from observing station to guns, in yards..(BG) = 1,200

Distance from observing station to target, in yards..(BT) = 4,500

Distance from guns to target, in yards.................(R) = 3,000

$$Lg = -50 \text{ x } 1.2 = -60$$

$$Lt = 10 \text{ x } 4.5 = 45$$

$$SI = 300 - \frac{\frac{Lg - Lt}{R}}{1{,}000} = \frac{-60 - 45}{3} = 300 + 35 = 335.$$

1212. Except where instruments are known to be in exact adjustment and ample time is available for calculating data, the site should be given in terms of the nearest multiple of five.

1213. If a very broad target sloping sharply at right angles to the plane of fire is to be attacked, it will generally be necessary, in order to secure exact adjustment to the fire, to vary the sites by a common difference from one flank of the line of guns to the other. The value of this common difference may be determined by finding the difference in site between the two flanks of the target and dividing this difference by one less than the number of guns firing.

1214. A change of site does not change the range to the point of burst in air, but increasing the site raises the point of burst in time fire and lengthens the range in percussion fire, while decreasing the site lowers the point of burst in time fire and shortens the range in percussion fire.

Percussion Fire.

1215. Percussion fire is principally employed for the destruction of material objects, such as walls, buildings, obstacles, artillery matériel, etc. Such fire is termed **fire for demolition.** It is also appropriate for fire against troops in woods or in confined spaces.

For the destruction of artillery matériel or other targets of low relief, light field guns may be used, but such use at ranges exceeding 2,000 yards requires the expenditure of much ammunition.

Time Fire.

1216. Time fire is employed for the attack of animate objects and aircraft, and gives more incendiary effect than percussion fire.

Corrector.

1217. The corrector setting should be such as will cause the mean point of burst to be about 3 mils high during fire for effect; about 1 mil high during fire for adjustment.

Due to variations in powders and fuse compositions and to atmospheric conditions, and to errors in the determination of the site, the most suitable corrector must be determined in each individual instance. Hence, at the commencement of fire, a trial corrector must be taken. This trial corrector is such as is suggested by previous experience with the ammunition in use and with local atmospheric conditions.

Method of Fire.

1218. In deciding upon the number of guns to be employed, the captain should consider the nature, size, importance, and range of the target to be attacked, the conditions of observation, the firing data already determined by previous fire, the supply of ammunition, the tactical situation.

1219. Fire by battery has the advantages of increasing the chances of discovering abnormal errors of gun service and of observing more than one round, thus establishing quickly the basis for changes of direction, height of burst, and range. When the range has been accurately determined it increases the probability of obtaining both shorts and overs at the first salvo and effect on a wide front of the target. It also has the advantage of at once setting all of the trail spades.

Fire by platoon has the advantage of simplifying analysis of the observation of individual bursts with respect to range, distribution, and height of burst, and of saving time in the launching of each salvo. It requires somewhat less ammunition than by battery and, in some cases, may increase the percentage of rounds correctly observed for range.

Fire by piece is appropriate to check a very doubtful deflection and, in some cases, for fire for registration.

1220. Salvos insure the identification of individual rounds and, with the exception of distribution, more accuracy in observation of fire. They are favorable to accurate service of the piece.

Volleys are faster than salvos and give better observation of distribution.

1221. Salvos usually commence on the leeward flank of the guns, in order that the burst of one round may not be obscured by the smoke or dust of the other.

Zone.

1221½. The reduced charges for the 6-inch howitzer are provided for cases when a greater angle of fall is necessary in order to reach objectives behind cover and in order that the trajectory may clear a high mask at short ranges.

The proper zone to use involves a consideration of these elements: Range, desired angle of fall, and height of mask.

Facility in the determination of the proper zone for fire at any particular objective may be acquired only by a careful study of the range tables and the solution of practical problems in their application. The following rules are general:

(*a*) Use zone 3 whenever practicable, as this gives a greater muzzle velocity and does not involve any alteration of the cartridge.

(*b*) By careful preliminary consideration avoid, if possible, the use of a zone which will require a zone change during the firing, as a zone change almost invariably requires a readjustment, with consequent loss of time.

Range.

1222. The initial range may be determined by means of a range-finding instrument, by angle-measuring instruments, and a measured base, by the use of maps, by sound. by estimation, from auxiliary observers, from previous fire, or from other units. Every auxiliary means, time permitting, should be employed to assist in the measurement of the range, since its correct predetermination is essential to promptness of effect. In many cases an officer must rely upon his own estimate of the distance. By constant practice it is possible to gain the ability to estimate distances closely, and it is imperative that artillerymen should acquire this ability. In such training distances should be estimated to permanent features of the terrain rather than to targets known to have been arranged for service practice.

1223. If the objective is indistinct, or if the air is calm or gently blowing from the range toward the observer, so that the smoke of bursts is likely to obscure the target for an appreciable time, the first range used should be somewhat long.

1224. If fire over friendly troops near the target becomes necessary, the first range used should be surely long.

Atmospheric Influences.

1225. The range and normal corrector are influenced by the atmospheric temperature and pressure. The effect of moisture in the air is negligible.

The lower the temperature, the shorter the range; the higher the temperature, the longer the range.

The lower the atmospheric pressure, or barometer. the longer the range; the higher the pressure. the shorter the range. In a high altitude, where the pressure is lower, the range is longer.

In summer, when the temperature is high and the barometer low, the range is long; in winter, when the temperature is low and the barometer high, the range is short.

An accelerating wind increases the range. A retarding wind has the opposite effect.

The lower the temperature, the more slowly the time train burns; the higher the temperature, the more rapidly it burns.

The lower the pressure, the more slowly the time train burns; the higher the pressure, the more rapidly it burns.

The normal corrector depends on both the range and the action of the fuze, so that the effect of atmospheric conditions on the normal corrector is the resultant of their effect on the flight of the projectile and on the fuze.

The lower the temperature, the higher the normal corrector; the higher the temperature, the lower the normal corrector.

The lower the pressure, the lower the normal corrector; the higher the pressure, the higher the normal corrector. In a high altitude the normal corrector is lower.

In summer the normal corrector is low; in winter it is high.

The effect of a high altitude upon the normal corrector may be either decreased or increased by the effect of temperature variations.

An accelerating wind lowers the normal corrector; a retarding wind has the opposite effect.

The daily variations in range and normal corrector caused by atmospheric conditions increase with the range. At ranges less than 3,000 yards daily variations are not important.

Summary.

1226. In determining the data for indirect laying, the following is a summary of the operations which may be carried ou when an observing station on the flank of the firing battery must be taken and a suitable one can be found within 400 or 500 yards of the pieces.

1. Select an observing station from which a good view of the target and its surroundings may be obtained, which is as close to the firing battery as the conditions permit and which is as nearly as possible on the prolongation of its front.

2. Select an aiming point which is surely visible from all the pieces whose direction is as nearly normal to the front as possible and whose distance from them is preferably not less than 2,000 yards.

3. Measure the angle from aiming point to target, the site, and the front of the target in mils.

4. Measure or estimate the distance to aiming point and to target and compute the parallax of each. Correct the parallax of the aiming point for obliquity if the line from the directing piece to the aiming point makes an angle greater than 400 mils with the normal to the front of the pieces.

If the observing station is at a considerable distance from the front of the battery prolonged, the parallax both of the aiming point and the target must be determined with reference to a platoon front on the line station-directing piece for use in computing the deflection of the latter, and with reference to a platoon front in the battery for use in obtaining the deflection difference.

5. Determine the convergence difference by Rule I, estimate or measure the distance to the directing piece, and apply Rule V for the determination of the deflection.

6. Determine the deflection difference by Rule II, III, or IV.

7. Correct the site, if necessary, for difference of level between observing station and the howitzers, adopt the corrector which previous fire has shown to be the most suitable. De-

pending upon the range and the desired angle of fall to reac the objective, determine the zone to be used and take tl range as measured or estimated.

8. To simplify computations platoon fronts are taken at 2 yards, the same as in the light field artillery, although tl normal platoon front of the heavy is 22 yards.

Example 1: A battery is ordered to take a masked position i observation and be ready to fire upon an indicated hostile ba tery whose range is known to be 2,100 yards. The battery cor mander finds an observing station 200 yards to the left of tl right piece and **on the prolongation of the battery front.** E selects an aiming point in rear 5,000 away. He finds that l has ample time to make accurate measurements and comp tations.

At the observing station he finds A=2,600 mils, F=3 SI=293. He notes that the observing station and the firi battery are practically on the same level. Therefore no co rection need be applied to the site as measured from his st tion. He notes that the mask of his own battery is so lo that any zone will cause his projectiles to clear it. He not that his target is protected by its gun shields only, and i firing shrapnel as great an angle of fall as is practicable desirable in order to get at the hostile personnel. His rang is 2,100 yards, the maximum limit of zone 1. If he uses zone thus getting the maximum angle of fall, he may run off tl range scale and have to pass to zone 2. He therefore throw out zone 1. Either zone 2 or 3 is applicable, so far as ra is concerned. Zone 2 gives the greater angle of fall. But t efficacy of shrapnel fired with zone 2 charges has not been full determined. He therefore decides to use zone 3.

He computes:

$P = -20/5 = -4$, or $= -3$ when corrected for obliquity ($A = 2600$).
$T = 20/2 = 10.$
$P - T = -3 - 10 = -13.$
$\frac{F}{X-1} = \frac{30}{3} = 10.$
$DD = -13 + 10 = -3.$
$n = -10$ to right piece.
$D = 2600 - 10(-13) = 2600 + 130 = 2730.$

And commands:

1. **Aiming point, that chimney.**
2. **Deflection, 2,730.**
3. **On first piece, close 5** (taking nearest multiple of 5 for the first salvo.)
4. **Site, 293.**
5. **Corrector, 65.**
6. **Battery right.**
7. **2,100.**

The operations are simplified if ample time is not available and approximate methods are used, taking the third piece, for example, as the directing piece.

$P = -3.$
$T = 10.$
$DD = -3 - 10 = -13.$
$n = -8.$
$D = 2{,}600 - 8\ (-3 - 10) = 2{,}704.$

1. **Aiming point, that chimney.**
2. **Deflection, 2,700.**
3. **On third piece, open 5** (10) (opened for parallel fire by 10 or 15).
4. **Site, 295** (nearest multiple of 5).

5. **Corrector, 65.**
6. **Battery right.**
7. **2,100.**

Example 2: A battery which has just taken a positio open and is firing upon a disorganized enemy is dire turn its fire upon a large body of infantry. The tar not be seen from the position of the guns.

The battery commander finds a place to the right fl slightly in front, from which he can see the target. U ruler, he measures the angle from a prominent tree column as 350 mils; he estimates distance to target yards, to aiming point 4,000 yards, to second piece 7 fronts.

He computes:

$P=5.$

$T=8.$

$P-T=5-8=-3.$

$n=7.$

$D=350+7(-3)=329.$

He estimates the target to be on the level with the g cides to use an open sheaf, and commands:

1. **Aiming point, that lone tree.**
2. **Deflection, 330** (nearest multiple of 5).
3. **On 2d piece open 15** (open by 10 for parallel fire).
4. **Site. 300.**
5. **Corrector, 60.**
6. **Battery right.**
7. **2,500.**

No zone is announced as he decides to use zone 3.

The captain estimates the **direction** of the third piece rect, the distribution as somewhat too large, the **height** as high (all four burst in air, mean height 15 mils), and the range as indeterminate (on account of the high bursts).

He commands:

1. **On 3d piece close 5;**
2. **Down, 10;**
3. **2,500;**

and fires such other salvos as may be necessary to effect the adjustment.

Example 3: A battery which has been firing shell (indirect fire) in zone 2 at a target in its immediate front is directed to open with shell upon a field work to the right of its present target. The captain having identified the field work determines by his B. C. telescope that it is 210 mils to the right of his present target with site 305 and that its range is 4,200 yards by the range finder. There is a 15-mile wind across the range from right to left. He decides to adjust with the right platoon and commands:

1. **Right, 210.**
2. **Site, 305.**
3. **Shell.**
4. **Right, left.**
5. **Zone, 3.**
6. **4,200.**

He observes both shots short the first 30 mils left, the second 15 mils left of the right edge of his target.

He commands:

1. **Right, 15.**
2. **4,400.**

He observes both shots over and correct for deflection within 5 mils.

He commands:

1. **4,300.**

He observes both shots correct for deflection within 5 but range doubtful.

He commands:

1. **4,300.**

He observes both correct for deflection within 5 mils and

He commands:

1. **4,250.**

He observes both correct for deflection within 5 mils and short.

He decides to pass to a battery salvo and commands:

1. **Battery left.**
2. **4,250.**

He observes three short and one over and that the third is 10 mils left of its proper place in the sheaf.

He commands:

1. **Third piece, right 10.**
2. **4,250.**

He observes all pieces are correct within 5 mils for defle and two overs and two shorts.

He commands:

1. **Battery three rounds.**
2. **4,250.**

Upon completion of this fire he is informed from front observers that the target has been materially damaged, an is ordered to keep it under a slow fire to prevent repair.

He decides to employ continuous fire at 10-minute inter using the second piece, and commands:

1. **2d piece only.**
2. **4,250.**

From this shot and the previous fire of No. 2 he decides to shift its fire 10 mils left and commands:

1. **Left, 10.**
2. **Continuous fire, interval 10 minutes.**
3. **4,250.**

He then directs the assistant to the executive to take charge of the firing of this piece and to vary the intervals slightly; to fire about 6 shots per hour, about half shrapnel and half shell. Corrector (as determined by his previous fire) 65. The tactical situation now admitting of this procedure, he arranges for the relief of No. 2 gun squad in two hours and permits the remainder of the firing battery to fall out. The captain remains in observation, but directs his reconnaissance officer to report in two hours to relieve him.

SECTION IX.—OBSERVATION OF FIRE.

1227. The officer conducting the fire, unembarrassed by details of the service of the guns, and assisted by members of the battery commander's detail, should devote himself to observing and correcting the fire and adapting its employment to meet the requirements of the situation. He should train himself to form accurate and quick estimates and to act on them with decision and boldness.

1228. To overlook ground which is invisible to the officer conducting the fire and to assist generally in the adjustment of fire, free use is to be made of auxiliary observing parties.

1229. Such parties occupy the most favorable observing stations which the conditions of the combat admit. Preferably they are as near the enemy as possible.

1230. Their special duties are to furnish information which will assist in the adjustment of fire and to keep the Artillery commander informed of movements of the targets or of our own troops which would affect the employment of fire.

1231. With respect to the adjustment of fire, they indicate especially whether the range is short, over, or correct; whether the burst interval, when in front of the target, is too great, too small, or correct; whether the direction is right, left, or correct.

If large errors in range are made, an observer on the flank of the guns will not usually be able to separate the errors in range from those in direction; in such a case the observer would ordinarily signal the direction only, as right or left, as it appears to him, and the officer conducting the fire, knowing the position of the observer, would deduce the sense of the salvo, volley, etc., in range. If the observer is to the right of the line of fire, shots striking short of the target appear to be to the left, while those striking over appear to be to the right, and vice versa if he is on the left of the line of fire.

1232. With respect to movements of the enemy, the observer reports especially: If the enemy abandons his position; if he shifts to the right or left, front, or rear to escape effective fire; whether hostile reenforcements enter the sector and their location.

1233. With respect to our own troops, the observer makes such reports as to their movements and situation as will enable the artillery commander best to assist them with the fire of the guns.

1234. Arrangement should, moreover, be made to obtain from advanced troops information which will assist in the adjustment of fire, and indication as to when fire should be commenced or discontinued.

1235. Sure and definite means of communication must be established between the artillery commander, his observing parties, and advanced friendly troops. If time and material admit, wire communication is provided, but visual signaling must always be relied upon to a greater or less extent.

1236. For observation of fire, for study of the terrain, and for the quick recognition of objectives, good field glasses are indispensable. All officers, agents, signalers, and scouts of field artillery should be equipped with suitable glasses and should be skillful in their use. A monocular glass is not suitable for observation.

1237. Field glasses should have a magnifying power of from 6 to 8 and a field of view or 90 mils or more. They should give even illumination and sharp definition and be dust and moisture proof. A means of adjustment to interpupillary distance is important. Independent focusing devices for each eye are preferable.

1238. At the commencement of the fire it is usually best to watch for the burst of the shots with the unaided eyes, for if a large error is made the bursts may not appear in the field of view of a telescope or field glass. After the bursts have been located the glasses may be quickly brought into play, if necessary.

As soon as the points of burst have been brought to the vicinity of the target they are observed by the aid of field glasses or the telescope, and all the indications carefully noted which assist in the determination of their relative positions with respect to the target.

1239. Sustained use of an observing instrument reduces acuity of vision. Glasses should not be used, therefore, except with a definite purpose.

1240. In order that any instrument may be quickly adjusted to the eyes, all observers should commit to memory their interpupillary distance and the eyepiece setting for each eye.

1241. The use of a mounting for field glasses re time during which they must be held to the eyes toward certain and continued identification of objec accurate study and observation of terrain and of fire.

1242. The line to an objective may often be co fixed by placing an object on the ground between i observer.

1243. Correction of fire is based on observation of air or on impact, and of effect upon the target or terrain.

Bursts in Air.

1244. A burst in air produces a ball of smoke w narily remains together for an appreciable time.

1245. When the shrapnel bursts, the smoke, whit gray in appearance, is projected in the direction o jectory. The point of burst is therefore always abov ter of the smoke ball. At ranges beyond about 2, the point of burst is near to or above the summit of ball, and the latter, observed from near the plane seen in a pear-shaped form, small end uppermost.

1246. When viewed from a flank, the direction of ball outlines the trajectory to a greater or less ext smoke from a group of shots, when viewed from a flan will give a definite idea as to the point at which trajectory meets the ground.

1247. An air burst after ricochet gives a pear-sha ball, with the broader end up.

1248. Occasionally a burst in air close to the groun a flattened smoke ball discolored by dust or mud able quantity, caused by the impact of a large number on a small area.

Bursts on Impact.

1249. When a common shrapnel bursts on impact the smoke l is discolored and fugitive, its upper portion wide and egular but somewhat flat.

1250. When a shell or high-explosive shrapnel bursts on im- t a large irregular columnar mass of black smoke and dirt is med, which remains visible for some time.

1251. The bullets and fragments from a burst in air knock a considerable amount of dirt and dust if they strike dry l; on wet soil splashes of mud are knocked up by the shrapnel and large fragments. Occasionally the effect of bullets l fragments may be observed in the flattening of long grass in the movement of brush or tree branches.

1252. An air burst of high-explosive shrapnel is followed by ercussion burst of the head. This ammunition, therefore, ords opportunity to obtain more information than does the mon shrapnel or shell. Care should be taken to distinguish impact burst of the head from a graze burst of the whole jectile.

Direction.

1253. Errors of direction of the sheaf of fire as a whole or individual rounds may be measured; if small, they may ually be estimated with sufficient accuracy by eye.

he measurement or estimation of these errors may best be de when the observer is near the line joining gun and target; wed from the flank, the error in direction is complicated h that in range, and its observation is particularly subject inaccuracy when the shots are fired at ranges sensibly differ- from that of the target.

Height of Burst.

1254. The height of a burst is measured or estimated fr the bottom of the target to the point of burst if the target is n concealed in trenches or behind a crest; otherwise it is mea ured from the summit of the covering crest.

1255. The height of a group of bursts is the mean of t individual heights of burst.

1256. In estimation, the observer may often refer the bu to some convenient point in the terrain, the angular distance which above or below the bottom of the target or the coveri crest has previously been determined.

1257. For convenience, bursts are classified as follows:

Graze: Bursts on impact.

Below: Air bursts below the target.

Graze below: Graze bursts below the target.

Low: Air bursts from zero to 2 mils above the bottom of t target.

Normal: Air bursts from 2 to 4 mils above the bottom of t target.

High: Air bursts from 4 to 6 mils above the bottom of t target.

Very high: Air bursts more than 6 mils above the bottom the target.

1258. Inaccuracy of observation is to be avoided by prom decision upon a consideration of the formation and normal a pearance of the smoke ball. Such inaccuracies are the sensi of bursts in air as lower than they actually are, due to sensi on an inappropriate part of the smoke ball; to the sensing low of graze or below bursts; and to the sensing as air bursts bursts after ricochet.

Range.

1259. It is rarely possible from a position near the guns to estimate with accuracy the amount of the error in range. Such estimates are usually too small and cause delay through an effort to correct the fire by making timid and insufficient changes in the range.

Attention should rather be concentrated on deciding, from careful observation of each shot. upon the sense of a number of shots fired with the same range and site, and on quickly inclosing the target with fire which is surely short and fire which is surely over. By narrowing the bracket thus determined effective adjustment may be secured.

A salvo or volley is considered **short** if all of the observed bursts are short; **over** if all of the observed bursts are over; **bracketing** if half of the observed bursts are over; **mixed** if the majority of the observed bursts are over and the minority are short, or vice versa.

The observer should train himself to decide quickly upon the sense of each shot as **short, over,** or **doubtful,** and upon the sense of each group of shots as **short, over, bracketing, mixed.** or **doubtful.** It may be necessary, however, to allow time for the smoke to form and reveal its relative position with respect to the target.

If the sense of a shot can not be definitely decided upon, it is doubtful and should be disregarded.

1260. The most accurate sensing of range is based on observation of effect on the target. Such observation will be more often possible in war than in peace. Next comes observation of bursts on impact, then of effect on terrain, then of the position of the smoke ball with respect to the target.

1261. Frequently irregularities of the ground or its nature prevent the observation of graze bursts so that low bursts in air must be sought. This is the usual case.

1262. If the observer is considerably above the target, or the target is on ground sloping toward the observer, the sense of a salvo (short or over) may usually be recognized readily by noting the relative position with respect to the target of graze bursts of the projectile or of the head of high explosive shrapnel or of fragmental hits from bursts in air.

Information obtained from the observation of the effect thus produced is reliable when it is observed as over; it should be accepted with caution when observed as short, unless the burst is low.

1263. If the target and its vicinity can not be seen from a superior elevation, if the ground near the target is at about the same elevation as the observer, or if the ground in front or rear of the target can not be viewed, the deductions as to the sense of the salvo are to be formed especially from the manner in which the puffs of smoke from the bursts affect the appearance of the target.

1264. If the outlines of the target are more clearly defined against the smoke of the burst, the range may always be considered as over, whether the bursts occurred in air or on graze.

1265. If the target is obscured by the smoke of the burst, the range may be considered as short; but, in the case of a burst in air, the burst must be low in order to warrant this conclusion.

1266. If the target is first obscured and then immediately silhouetted by the smoke or dust, or the reverse, the range is nearly that of the target.

1267. If the target is indistinct and of about the same color as the smoke, it may be less visible against the smoke as a background. A burst beyond the target may, for this reason, sometimes seem to obscure the target, and hence be judged short, when it is in reality over. On the other hand, some targets become very much more visible if projected against a smoke background.

1268. If the actual point of burst is observed in line, or approximately so, with the target and is below it, the range is short. If a graze burst is observed above the target and in line with it, or nearly so, the range is over. Occasionally a graze burst wide of the target may be sensed for range through careful study of the terrain.

1269. Frequently the target occupies terrain of such a nature as to justify sensings of rounds, when the deflection is known to be approximately correct, as lost over. But soft or swampy ground may completely smother a burst and prevent sensing.

1270. If the wind is blowing up or down the range, a decision should be formed quickly as to the relative position of the smoke with respect to the target. But if the wind is blowing across the range, it may be better to wait until the smoke has drifted across the front or rear of the target. To secure this result it may be desirable to direct the fire at the windward flank of the target.

1271. In observing bursts with reference to a crest, care must be taken not to be deceived by a crest parallel to the crest sought but short of it. In rolling country such an intermediate crest is often present, and it may merge into the background formed by the higher ground in its rear, and hence escape detection, while, as a matter of fact, there may be a broad valley or depression between the two crests. Shots observed against the near side of the intermediate crest are short and easily sensed, but shots which pass over the intermediate crest and burst low or on graze in the valley between the two and are lost may be thought to have cleared the farther crest and erroneously sensed as over. Such deceptions may be avoided by obtaining bursts in air on the line adjoining the observer and the crest sought. If the ball of smoke is cut in two by the crest and the crest clearly defined against it, the burst is over. If the crest is concealed by the smoke, the burst is short. The short bursts may often serve to reveal the existence of the intermediate crest by causing the latter to be silhouetted against the smoke.

1272. When the smoke of burst rises from behind a crest, the burst is over the crest.

1273. When the burst is in the direction of a wood, the smoke ball may present a ragged appearance due to its being partly hidden by branches or foliage. The indication is that the burst is beyond the near limit of the wood.

1274. If the sun is shining, information as to the sense of burst in air may often be obtained by observing the shadow of the smoke ball on the ground. The height of the burst and the position of the sun must, however, be taken into consideration.

1275. In certain cases, such as in fire against air craft, fire at night, fire against masked targets, range sensings will be either extremely difficult or impossible from the vicinity of the guns. Recourse is then had to lateral observes.

The more uncertain the direction of fire or the greater the range of the target, the greater should be the distance of the observer from the line of fire.

1276. Observations of range from lateral positions are complicated by errors of direction. But if the direction is correct all shots seen by the flank observer will be over if they are on the side of the target corresponding to his side of the line of fire, and short if they appear on the opposite side of the target.

SECTION X.—OBSERVATION OF TERRAIN.

1277. An accurate conception of the terrain in the vicinity of the target increases the number of rounds which may properly be called sensible. Preparatory to opening fire the study of ground forms around the hostile positions should be taken up, and this should be continued during the action. Auxiliary observers may give valuable information. If maps are available, they should be studied. Practice in making position and place sketches and a comparison of the sketches with the actual terrain will increase facility in judging ground from a distance.

1278. It is necessary to locate ravines or hollows which might catch and hide the bursts. The smoke from such bursts is apt to rise and reveal itself after a time, but false deductions may be drawn from it. Thus, the smoke from a burst short of the target may have become so much dissipated by the time it appears that the target may be seen through it and the impression produced that the target is silhouetted against the smoke. Moreover, if a strong cross wind is blowing, the smoke, when it appears, will probably be at some distance to the flank of the actual point of burst, and erroneous conclusions as to the direction of the salvo may thus be reached. Such false deductions may be avoided, however, if the lay of the ground is appreciated and considered.

1279. The existence of unexpected ravines and hollows may sometimes be deduced during firing from the fact that while bursts in air are seen the points of impact of the fragments are not revealed by the dust and dirt knocked up.

1280. Indistinct targets whose location is only approximately known will sometimes be disclosed by bursts beyond them. It may be advisable to search for such targets by firing at varying ranges and deflections. Volleys and salvos with a wide distribution will often favor this purpose.

SECTION XI.—OBSERVATION FROM AIRCRAFT.

1281. The study of terrain and the location of targets without overhead concealment by observers in aircraft are very practicable.

The designation of objectives is difficult. It is possible, however, by several methods, such as by photography, by sketches, by reference to squared maps, by description, by their relation to reference points. Range and direction may be approximately determined by use of the range finder and the aiming circle or telescope in observation on a mobile aircraft at the moment when a prearranged signal indicates that it is over the target.

1282. In observations of fire from a great height, bursts in air and bursts on graze may both be seen; but it is difficult to judge the height of the burst center except by the ratio between the numbers of air bursts and graze bursts. In both range and direction the relation of the shots to the target is easily determined.

Effect from shrapnel bullets can not be observed.

SECTION XII.—CONDUCT OF FIRE.

1283. To fire effectively it is not sufficient merely to know and to observe the technical rules; they must be properly applied, with all the variations of which they admit, in order to obtain the maximum useful effect, considering both the tactical situation and targets. As targets vary in vulnerability and are not equally dangerous, different targets may properly be attacked by different methods.

1284. Hitting the target is the most tangible and least questionable form of useful effect, because the essential object of artillery is destruction of the adversary.

If this destruction can not be accomplished, the effort may, at least, effect the neutralization of the enemy by imposing upon him a partial or complete state of inactivity. In addition, the guns bring a moral support to friendly troops, and may divert from them the attention and fire of the enemy.

1285. Artillery may produce important effects of **neutralization, moral support**, or **diversion.** These will be the more surely obtained if they are accompanied by great physical effect, but they may be obtained though physical effect is slight. These effects are to be considered in the decision to start or stop the fire or to vary its intensity.

1286. The terrain should be closely observed and studied, with a view of determining whether or not it offers cover to the enemy, or visible points, which can be used either as aiming points or as reference points to facilitate the identification of targets.

1287. Preliminary adjustment may be dispensed with only when the necessary data have been determined by previous fire, or when the range is very short.

Fire for Adjustment.

1288. During adjustment, observation is the first consideration.

1289. By observing the points of burst or fall and judging their relative positions with respect to the target, the modifications in the deflection, corrector, site, and range settings requisite for more certain observation and for adjusting the fire upon the target are determined.

1290. Adjustment is effected upon the target itself, if practicable. In many cases, however, the target will not be visible to the officer conducting the fire, though its approximate position may be known. Thus, the target may consist of troops concealed behind a ridge, or behind a wall or hedge, or in the edge of a village, a forest, or a field of standing grain.

Some prominent feature of the terrain in or near the enemy's known positions—for example, a tree, a house, a mass of rock, etc.—is then selected as a registration mark, and by means of scouts, observers in balloons, or any available means, the enemy's location with respect to this mark is determined within the narrowest possible limits.

The fire is then adjusted upon the registration mark, and the area within which the target has been located is searched by the subsequent fire.

1291. If the circumstances permit, advantage may be taken of lulls in the action to secure at least a rough adjustment upon localities in which the enemy is known to be or near which he is expected to appear. Such a fire is termed **fire for registration.** The data are thus secured for opening promptly an effective fire upon an enemy appearing at or near the positions upon which the fire has been registered; by minor modifications in these data a quick adjustment on the target may be secured.

1292. Fire for registration may be conducted to discover accidents of ground which might conceal an enemy or hide the points of burst of our projectiles.

1293. Registration of fire is especially appropriate for artillery to which definite sectors of observation have been assigned.

If the enemy's position within the sector has not been located, the artillery commander proceeds in a systematic way to secure the data which will enable him to reach promptly and effectively any part of the sector. He studies the terrain, decides upon the limits in width and depth of the area to be registered, notes the specially prominent features of the terrain within these limits, and by actual firing directed upon these natural features secures the data which will enable him to reach promptly any target appearing in their vicinity.

1294. Fire for registration should never be used if the location of the fire unit is likely to be thereby revealed.

1295. Adjustments of four kinds are required, viz:

1. In direction.
2. In distribution.
3. In height of burst (in case of time fire).
4. In range.

Adjustment in direction involves the establishment of a deflection to bring the sheaf of fire to bear upon the target.

Adjustment in distribution involves spreading the sheaf upon the desired front of target. Modifications of deflection setting are hence necessary.

Adjustment in height of burst involves the determination of a corrector setting, which will cause the mean point of burst to be at the desired height.

Adjustment in range involves the determination of a range setting which will cause the mean trajectory to pass through the target, or, if this is not practicable, the range settings corresponding to the short and long limits of a bracket which surely contains the target.

These adjustments are carried on simultaneously.

1296. The points of burst of a series of shots fired with the same data, even from a single gun, will vary in range, in direction, and in height of burst, due to inaccuracies of the personnel and to variations in ammunition, matériel, and atmospheric conditions. Hence dispersion is to be normally expected, and minor changes in firing data should not be based on the observation of a single shot.

A minor change is one which is less than the probable error.

Deflection.

1297. When direct laying is employed, the executive makes such changes in deflection as may be necessary to bring the fire of each gun to bear upon its proper portion of the target. When shots go wide of the target, it should be more accurately designated.

1298. It may often occur that, though the initial direction has been given by direct laying, yet the gunner, on account of smoke, haze, or the indistinctness of the target, is unable quickly to locate it after looking away. Gunners should, in consequence, be trained always to note some mark on the ground which will enable them either to find the target or to bring their guns back to the initial direction by using this mark as a registration mark. If, however, the conditions are such as to render it probable that delay or inaccuracy will thus be occasioned, the captain should at once change from direct to indirect laying.

1299. When indirect laying is employed, the officer conducting the fire adjusts the sheaf.

1300. To overcome observed errors in direction, the error of the piece which is most nearly directed upon its proper part of the target is measured or estimated in mils and a corresponding correction in deflection is applied in the appropriate sense. The correction is habitually applied in even multiples of 5 mils until approximate adjustment in direction is secured, when a correction of less than 5 mils may, if necessary, be made.

1301. Fire having been directed upon the target, it may be shifted to another by increasing the deflection if the shift is toward the left, by decreasing if the shift is toward the right.

The change in deflection necessary for this purpose is determined by measuring the angle in mils between the old target and the new and correcting it as though the old target were the aiming point. Thus the parallax of both targets must be considered and, sometimes, their obliquity.

1802. If salvos or shots are lost, one or more high-bursting shrapnel fired from the directing piece will permit the determination and rectification of any error in deflection; or, in percussion fire, the range may be changed to obtain impacts on favorable ground.

Deflection Difference.

1803. A change in deflection difference is based on the observation of the preceding salvo. It should be made on the piece which, for that salvo, is nearest to its proper direction on the target or on which the deflection is changed; and should be announced ordinarily in the multiple of five nearest to the measured or estimated value.

1804. As adjustment progresses the fire may be either concentrated or distributed. If observation is difficult, concentration upon the most prominent part of the target may be advisable; if at the same time a cross wind is blowing, a point of adjustment to the windward of the target may be selected. If observation is easy and the front to be attacked is not great, the fire may be distributed from the beginning, the direction and distribution being such as to take advantage of any drift of the smoke balls.

1805. If several batteries are adjusting simultaneously upon a single broad target, then it is generally best for each to concentrate during the adjustment upon the corresponding part of its section of the target—for example, the windward flank.

1806. The simultaneous adjustment of fire by several batteries upon the same target should not be attempted unless it is possible to distinguish clearly the shots of the different batteries firing. If this condition is not fulfilled, the adjustment should be made by one battery only and verified by the others in turn.

Height of Burst.

1307. For adjustment of time fire a low burst center giving a large percentage of bursts on graze is desirable. The opportunity is thus given to observe both bursts in air and bursts on graze. The visibility of the former is little affected by the profile of the ground and the state of the soil, and, taken in connection with the latter, they enable the observer to determine quickly the irregularities of the ground in front and in rear of the target. Moreover, considerable effect may be produced during the adjusting series, and, by a small change in the corrector, passage to fire for effect may be quickly accomplished.

1308. When one-half of a salvo burst on graze and one-half in air, a mean height of burst of 0 mils is indicated.

When of a group of shots fired with the same data three-quarters burst in air and one-quarter on graze, a mean height of burst of between 0 and 2 mils is indicated. In the reverse case a mean height of between 0 and 2 mils below the ground is indicated.

These conclusions will be modified if, in addition to the proportion of graze and air bursts, the actual heights of burst be considered. For example, if three bursts are very high and a fourth is on graze, the latter should be disregarded. Thus the question of dispersion affects the conclusions as to the correction of height of burst that may be drawn from a comparison of the number of bursts in air and on graze.

1309. When the mean point of burst is at a height appropriate for adjustment, about one-third to one-half of the shrapnel may, on account of errors of the fuze, of laying, etc., be expected to burst on graze.

So long as these proportions are maintained no change in mean height of burst for adjustment is in general advisable.

1810. The apparent height will differ from the true height of burst if the observer's distance from the target is materially different from its range from the guns or if he is higher or lower than the guns.

If he is nearer than the guns to the target, the apparent height will be greater than the true height: if he is farther away, it will be less.

If he is higher than the guns, bursts in air beyond the target will appear higher, burst in air short lower than they actually are. If he is lower than the guns, the reverse is the case.

The effect of such conditions must be fully considered in correcting data.

1811. Conclusions are to be formed from the observation of a group of shrapnel fired with the same fuze setting, the average height of the bursts being considered. Hence battery salvos afford the quickest and most reliable means of adjusting the height of burst.

1812. Salvos in which the heights of burst are very irregular should not be considered. The irregularities are due to faults of the battery in setting scales and fuzes and in laying.

1813. The height of burst may be regulated by changes of site or corrector.

1814. If the first group of air bursts is too high for observation of the smoke balls as to range, their mean height is measured or estimated and a change is made surely sufficient to bring the burst center to the bottom of the target.

If the bursts are in air below, the burst center is similarly brought to the bottom of the target.

If a target has been bracketed for height of burst, intermediate corrector settings are used for more accurate adjustment.

1315. Any increase of site raises the point of burst; any decrease lowers it.

If the first salvo bursts on graze at 10 mils or more below, or at 15 mils or more above, an equal change in site should be made to avoid the possibility of exceeding the limits of the corrector scale.

The measurements on which changes in site are based should be as accurate as practicable.

1316. An impact over indicates that the time of burning was too great and that if the trajectory were raised the point of burst would be beyond the target.

An impact short, however, may not be followed by an air burst short if the trajectory is elevated, for it is possible that the corrector is much too low.

When the impact has been observed at a considerable distance short of the target, it may be expected, with good chances of being correct, that the same corrector will give a burst short after the trajectory has been raised.

1317. The advisability of raising the burst center when both rounds of a platoon salvo burst on graze is much less than is the case when all rounds of a battery salvo burst on graze.

1318. When the site is correct, if all the bursts of the first salvo are on graze below or on graze not more than 2 mils above the target the corrector should be raised, using a multiple of 5. If, after raising the corrector, grazes are still obtained, the corrector should be raised by similar changes from salvo to salvo until air bursts are obtained.

If all the bursts of the first salvo are on graze more than 2 mils above the target, the corrector should not be changed for the next salvo.

1819. Changes in the corrector of 2 mils or less should be based on the observation of at least four air bursts.

NOTE.—The fuze setters are so constructed that if a shrapnel be fired with its fuze set at a given range and at normal corrector (60) it will burst under normal conditions not at the range used but sufficiently short of this range to place the point of burst, as viewed from the firing point, at the following heights arbitrarily adopted by the Ordnance Department above the point of fall of the trajectory for the given range:

Zone 1: 30 mils.
Zone 2: 20 mils.
Zone 3: 10 mils.

The amount of actual firing with the 6-inch howitzer has been so limited that definite rules can not be given for the conduct of fire. The corrector to be used should be based on previous experience, and in the absence of previous experience upon the above information as to its construction for normal conditions. The efficacy of shrapnel fired with zone 1 or zone 2 charges has not been fully determined.

1820. When indirect laying is employed, an error in the site will cause a corresponding and equal error in height of bursts. As the cause of the latter error may not at first be known, adjustment of the height of burst by changing the corrector may be attempted. If the error in height of burst is not great, it may readily be allowed for in this way; but if it is seen that the necessary correction will exceed the limits of the corrector scale, the total correction which has been applied to the corrector must be transferred in the same sense to the site, and a return to a corrector setting near the normal must be made.

The foregoing emphasizes the importance of determining the site as accurately as possible in the first place. It also shows that when the firing data for indirect laying are passed from a battery in action to one just about to take part, not only the range, but also the corrector and site which have been used with that range in securing the adjustment must be communicated.

Range.

1321. Adjustment for range is usually the most difficult to obtain. One reason for this is that while nearly all rounds fired are observed for direction, distribution, and height of burst, only about 50 per cent of all rounds fired for adjustment on fairly difficult terrain are correctly observed for range. Increased facility and skill in making correct observations for range lead to quicker and more accurate adjustment.

1322. The depth of effect from a single shrapnel is small, as is also the radius of action of the shell.

1323. Against targets without depth there is always a single most effective range. Due to the inherent errors of the matériel, to errors of even well-trained personnel, to the difficulty of making correct observations, and to the fact that most targets do have depth, it is, however, seldom possible to determine one gun range exactly appropriate to a target when using time fire. Moreover, the tactical situation frequently, if not usually, imposes conditions demanding greater or less rapidity in obtaining effect. In all cases accurate adjustment of fire to the narrowest possible limits results in increased effect and saving of ammunition.

1324. The refinement to which fire for adjustment can be carried depends to a great extent on the tactical conditions. But tactical conditions also influence the degree of accuracy with which the fire may be adjusted. For example, the lack of visibility of the target or other conditions affecting observation may oblige the acceptance of a more or less uncertain adjustment. Many targets are able to shelter themselves from fire. Hence early physical effect must be obtained unless moral effect only is sought. In time fire there is necessarily a moment when adjustment must cease, for the most suitable height of burst for producing effect is not a suitable height for observing for range. For all those reasons, then, adjustment for range usually consists in determining two ranges, one of which is less than the true range of the target and one of which is greater. This method determines a bracket within which there is some certainty of the target being located. The measure of this certainty is dependent upon the number of correct observations at either limit. The depth of the bracket to be sought and the certainty with which the bracket actually contains the target depend upon the technical and tactical conditions and upon the kind of fire used. The same conditions which justify seeking a narrow bracket justify or even require an endeavor to obtain a sufficient number of correct observations to make it practically certain that such a bracket contains the target.

1825. Thus there are two questions influencing the degree to which adjustment should be carried. Is it preferable to obtain a very powerful effect, without much regard to time, with a comparatively small amount of ammunition? Or, will it be best to obtain a sufficient effect in a short time without much regard to ammunition? In any case it is to be remembered that a poorly adjusted fire is ineffective.

1826. When a narrow bracket is sought, adjustment should be carried sufficiently far to give confidence that it actually contains the target. On the other hand contentment with a wide bracket, except when such a bracket is imposed by difficulties of observation, etc., implies that the definite establishment of the bracket through the correct observation for range of several rounds at each limit is not justifiable if time is thereby sacrificed.

1827. If the target is surely included within the limits of the bracket finally accepted, it may be reached more or less effectively by subsequent fire. The first consideration, then, is to determine that fire at a certain range is surely short of the target, and that fire at another and longer range is surely over the target. A second but very important consideration is to reduce the difference between those two bracketing ranges as much as possible; that is, to obtain the smallest bracket compatible with the circumstances of the case.

1828. If the first range is short, the range is increased; if over, it is decreased and rounds are fired successively, increased or decreased in range, as the case may be, until the target is bracketed.

Having bracketed the target, the size of the bracket may be successively reduced by halving the last bracket obtained; that is, by firing at the mean of the last two bracketing ranges.

1829. The amount of changes in range for obtaining the first bracket depends upon the accuracy of preparation of fire and the nature of the target.

1830. When ranges are estimated or taken from a map on which the positions of guns and target can not be accurately located, the first bracket should be obtained by changes of 400 yards.

When an accurate range finder has been expertly used, or when the range has been accurately determined by other means, 200-yard changes are appropriate.

1831. In firing over friendly troops near the target the racket may be obtained by beginning with a range which is urely long and by smaller successive changes of range.

1882. No burst should be sensed unless the officer conducting the fire obtains from it information sufficient to form the basis for a definite opinion. If there is any doubt in his mind, the burst should be sensed as doubtful. Having once sensed a burst as short or over, the captain should not hesitate to base a change of range on such sensing; but whenever time or the conditions of observation permit, the limits of the brackets, particularly the short limit, should be based upon the sensing of three or more bursts.

1883. Correctly observed bursts indicate a short range more surely when they are low; a long range is more certain when the correctly observed bursts are high.

1884. If the sense of the bursts is doubtful, or if the bursts are lost, circumstances must decide whether to change the range or to change only other firing data for the next round.

If the smoke of the fire of other batteries has interfered with observation, a salvo concentrated upon some prominent part of the target may be of assistance.

If the doubt was occasioned by the fact that the bursts were in air and high, it may be well merely to lower the point of burst for the next salvo.

If a salvo is lost, the projectiles have probably burst wide of the target or in a ravine or behind some intervening cover. If the smoke of the bursts does not rise and become visible after a few seconds, the lay of the ground should determine whether to increase or diminish the range or merely to raise the corrector so as to obtain visible bursts in air. Definite information may generally be most quickly obtained in such cases by securing time bursts just above the level of the crests or other cover.

1885. The trajectory may be brought upon the target by changing the site or by diminishing or increasing the range setting. In the latter case, if the site is in error the fuze will be set for a range other than the true range to the target, its time of burning will be too short or too long, and the projectile will burst too high or too low, as the case may be. Modifications of the corrector or of the site will in general be necessary to bring the mean point of burst to the desired height. If the error has been small, it may readily be overcome by a proper use of the corrector.

Heights of burst varying greatly from those expected may be due to large changes in range or to changes in atmospheric conditions. However, when the approximate corrector setting is known, heights of burst which are apparently abnormal may usually be attributed to an erroneous site. If the error has been great, delay may result in the adjustment of height of burst by the use of the corrector. In such a case it may be advisable to change the site, for when it is considerably in error data obtained from firing at one target are of little assistance in ranging upon another. In general, the best results will be obtained by changing that element which is most probably wrong.

If the range has been determined by range finder or other accurate methods, the use of a correct site will greatly increase the probability of early effect upon the target.

1336. In the accurate adjustment of time fire, not only the height but also the burst interval is important; for projectiles bursting too far in front of the target and those bursting in the air above it produce little or no effect. The burst interval is correct when both the range and the height of burst are correctly adjusted. Indications that such is the case are: (1) That the bursts on graze bracket the target; (2) that the mean height of burst is about 3 mils; (3) that fragments from the air bursts strike the ground both in front and rear of the target, and that the pattern made by these fragments, as revealed by the dirt and dust knocked up, is close and dense rather than greatly extended; (4) that obvious effect is produced upon the target.

If doubt exists as to the burst interval, it is best to lower the corrector and get a group of low bursts or bursts on graze.

Observers posted well to the flank of the line of fire may be of the greatest assistance in determining and correcting errors in the burst interval.

1837. At medium ranges a change of 4 mils in the site produces a change of about 100 yards in range; hence, if the site is materially altered, the adjustment of the range will have to be recommenced.

1838. At medium ranges a change of 4 points in the corrector produces a change of about 100 yards in burst range.

1839. If physical effect upon the target is observed, the range used is approximately that of the target.

If a bracketing salvo is observed, the range is a little long if the bursts were in the air; approximately correct if the bursts were on graze.

A mixed salvo over indicates too long a range. A mixed salvo of air bursts short indicates an approximately correct range; of graze bursts short, a short range.

1840. The minimum bracket possible of determination depends upon the accuracy of the gun. The establishment of a bracket narrower than the 50 per cent zone is difficult.

The bracket to be used depends upon the tactical situation and conditions of observation.

1841. Against stationary targets—for example, artillery in position or immobilized troops—a bracket of 100 yards should ordinarily be sought.

Against targets moving slowly or capable of slow m
only—for example, heavy artillery, troops in defiles, conv
a bracket of 200 yards should be attempted.

Against transient targets—for example, infantry in acti
in bodies that can quickly disperse or seek cover, or ma
guns firing—a bracket of 200 yards is usually the narro
that can be attempted.

Against troops moving or likely to move rapidly in the d
tion of the range—for example, mounted troops not con
by the terrain—it is usually advisable to bracket by chang
600 yards in range and to attempt no narrowing of the br
thus obtained. If the target is approaching, and the long
of the bracket has been last determined, it is often advi
to fire again at the short limit in order to make sure wheth
not the target has passed out of the bracket. If the targ
withdrawing and the short limit of the bracket has been
determined, it is often advisable similarly to make certai
the long limit. The use of the range finder is especially in
tant in determining quickly whether a rapidly moving targ
approaching or withdrawing.

When a reliable range is used, and the situation dem
early effect, a bracket of 400 to 600 yards may be assu
based on the observation of the first salvo.

Against instantaneous targets—for example, observ
parties or staffs—no bracket is sought, but time fire is exec
over a wide front and great depth at maximum rapidity.

1342. Unless there is actual necessity for early effect,
short limit of a bracket should be based on the observatio
more than one round.

1343. It is always permissible in shrapnel fire to bas
long limit of a bracket upon a smaller number of observ
than is necessary for the short limit.

1844. As the depth of the bracket decreases, so should the
mber of observations on which each limit is based increase.

1845. If percussion fire is to be used for effect on material
jects, called **fire for demolition**, very accurate adjustment of
nge is required. Such fire is effective at all ranges but, be-
use the probable error in deflection increases and the danger
ace decreases, while observation grows more difficult as the
nge becomes longer, effect can often be obtained at the longer
nges only at the expense of much ammunition.

The adjustment on large targets may usually be determined
m the effect observed.

For the demolition of Artillery matériel and other targets of
v relief, the adjustment in range is never completed, but is
rried on to the end of fire for effect. When the 100-yard
acket is definitely determined by at least four observations of
unds fired at each of the limiting ranges, fire is continued at
e mid-range of the bracket. Here both **shorts** and **overs**
ould be observed, and fire is maintained until, of at least eight
servations, their numbers are found to be nearly equal or until
lecided preponderance of one over the other is established. So
ng as the **overs** and **shorts** are nearly equal the adjustment
very close and the range should not be changed. But as soon
either **shorts** or **overs** preponderate in a ratio greater than
o 3 the range is changed by 25 yards in the appropriate sense.
anges less than 25 yards should not be made.

If at any range used before the 100-yard bracket is estab-
hed, such results are observed as those discussed above for
e mid-range of the bracket, the subsequent procedure should
ewise depend upon the equality or preponderance of **shorts**
d **overs**. If they are equal, or if their ratio is not greater than
to 3, firing at that range is continued; if the preponderance

is greater than 5 to 3, the range is changed by 50 yards in th appropriate sense, and adjustment is then continued as describe

Percussion fire may be said to be adjusted only when effect i plainly observed, or when, of many rounds fired at a single rang the number of overs is equal to or slightly greater than the nun ber of shorts.

Method of Fire.

1346. Often the method of fire most suitable for adjustmen will conflict with the requirement of very early effect. Refin ments of adjustment warn the adversary, thus remove the el ment of surprise, and prompt him to measures to avoid losses.

Every means must be utilized to simplify the operations o adjustment and shorten their duration.

Fugitive targets may be attacked with high chances of su cess if the fire is carefully prepared against points and area likely to be occupied and the data corrected from time to tim in accord with the results of actual firing.

1347. The rapidity of fire during adjustment will be co trolled by the necessity of observing the shots and setting o the necessary corrections. Rapid and correct decisions an quick commands on the part of the battery commander wil increase the rapidity of the adjustment of fire.

1348. The method of fire to be employed depends upon th nature and situation of the target and upon the method of layin

Against stationary targets—for example, inanimate obje tives or troops intrenched or otherwise immobilized—or in regi tration of fire the adjustment in range, in height of burst, an in distribution is usually secured by salvos.

Against slowly moving targets also—for example, large bodie in column of route or wagon trains—the adjustment is usuall secured by salvos.

Against rapidly moving targets—for example, Cavalry charging or Artillery changing position—the adjustment is secured by volleys with direct laying, by volleys or salvos with indirect laying.

Against transient targets—for example, Infantry in action in the open or Infantry marching in small bodies or machine guns firing—the adjustment is usually secured by salvos.

1849. The kind of projectile to be used in adjustment is ordinarily the kind that is to be used for effect. The choice depends upon the nature of the target and its situation.

During fire for effect time fire is, as a rule, employed against animate targets, aircraft, searchlights; percussion fire against other inanimate targets.

1850. During adjustment it may become necessary to change from time fire to percussion fire to lessen the probability of hitting friendly troops or for the purpose of narrowing the bracket.

1851. When fire has been adjusted with shrapnel and it is necessary to use shell the mid-range of the bracket is the most appropriate and fire at that range should be continued until at least three rounds have been sensed.

1852. It may be necessary in some cases to assign special targets to certain pieces or to certain platoons. In such cases the chief of section or the chief of platoon conducts the fire of his gun or guns, unless the captain gives other instructions.

Adjustment from Aircraft.

1853. When adjustment must be based on the results of observation communicated from aircraft the various elements of firing data can not usually be corrected simultaneously. By firing with a single piece the deflection may first be adjusted. This is followed by adjustment of the distribution. Then the bracket for range is obtained. Finally, from a consideration of the ratio between air and graze bursts the height of burst may be established.

Effect can not be observed unless it be great but effectiveness of fire may be inferred from the target's movement or effort to obtain cover or from other indications.

Adjustment by observation from kite-balloon.

1353(1). Rounds must fall close to the line observer-target. This line is bracketed by changes of either range or deflection. If the angle observer-target-battery is less than 800 mils, changes of deflection are best; if more, changes of range.

When rounds have been brought to the line observer-target they can be kept there by changes of deflection corresponding to bounds in range.

Let R be the range last used.

Let T′ be the angle observer-target-battery.

Let D′ be the deflection correction for a bound of 100 yards.

Then $D' = \frac{100\ T'}{R}$.

It is additive (subtractive) for increases of range if the battery is to the left (right) of the line observer-target.

It is subtractive (additive) for decreases of range if the battery is to the left (right) of the line observer-target.

1353(2). When shrapnel is used, one or more graze burst must be early obtained and air burst must be kept low.

1353(3). The following information must be received by the battery from the observer:

a. Before firing:

1. The map-square above which the balloon is located.
2. The direction and velocity of the wind.
3. The height of the balloon.

b. Before each round:

4. Announcement that the observer is ready to observe.

1858(4). Before each round the observer must be informed rom the battery as follows:

1. Nature of projectile to be fired.
2. Warning that piece is to be fired, as **Ready** or **Stand by.**

observer replies **Stop,** in which case firing ceases, or **ay,** in which case the piece is immediately fired.

1858(5). At each discharge the word **fired** is immediately **to the balloon.**

1858(6). As it is essential that telephone communication be **nterrupted,** the operator devotes his attention solely to the **ire from** battery to balloon and does not remove his receiver **r any purpose.**

1858(7). The observer refers his observations to the line **bserver-target** and to the target, and reports:

Right (Left), (so many) mils; or
Graze (Air), Short (Over); or
Doubtful; or
Lost.

Air, Short (Over), reports a burst in air below (above) the **ne of observation.**

Sensings as to range, **Graze, Short (Over),** will not be given **cept** when the round is observed on the line of observa**on,** unless the observer is perfectly confident of his sensing **cause** the point of fall is actually at a feature surely recog**zed** on the map in its relation to the target.

Doubtful rounds may be qualified by descriptions, as **Smoke ifting to left behind target,** or **Smoke rising (so many) mils ght.**

Fire for Effect.

1354. Every target attacked will present its own problem, which must be solved according to existing conditions and not by adherence to any fixed rule.

1355. Having obtained the desired bracket, no time should be lost in making the area thus inclosed untenable for any hostile force. The adjustment should be continued during fire for effect by constant observation with a view of discarding ranges obviously ineffective, of confining the fire to ranges which appear to be effective, and at the same time, of making such corrections in height of burst, deflection, and distribution as will perfect the adjustment or meet changes in the location or formation of the target. It is to be expected that targets having mobility will not remain immobilized under effective fire. The captain should, therefore, be ready to adapt his adjustment to changing conditions at the target. It will seldom be possible to spend sufficient time and ammunition to obtain an adjustment close enough to justify remaining at a single range during the delivery of fire for effect.

Ranges may be considered effective when it is evident that effect is being produced upon the target; when the great proportion of bursts in air is short of the target and at the proper mean height; when the shrapnel cases are seen to strike at or near the target; when dust, if seen at all, is knocked up by the bullets both in front and in rear of the target.

1356. Only direct hits are effective against material targets or shielded batteries when percussion fire is used.

Range.

1357. In time fire, the short and long limits of the bracket determined during the initial adjustment should be considered losing an area to be covered during fire for effect at suc- ranges. This can be accomplished by opening fire for and using either successive increments or successive nents so that the target will be covered at one or more ranges used. The officer conducting fire may be able to in opinion as to which are the most effective ranges. The ange differences should usually be 100 yards, but when ea has been narrowed as a result of observation they may uced to 50 yards.

8. In firing at moving targets the first range used should rily be that limit of the bracket toward which the target ing.

first range appropriate for other targets depends upon eration of the purposes of the fire for effect, the condi- of observation, the position of friendly troops.

9. A bracketing battery salvo indicates an effective range. such a salvo gives sufficient indication of the corrector nditions demand immediate effect, fire for effect should d at that range and reliance placed upon observation n fire to determine whether or not it is actually effective. the corrector is not established and when certainty of ment is more important than immediate effect, the adjust- should be continued, using the same range. In any case ust be taken lest the bracketing salvo be due, in part at to the obliquity of the target.

0. The uncertainty of a bracket may be compensated for rching a greater depth than that indicated by the observa- but the principle should only be applied to those cases ding immediate effect.

actical or other conditions make it desirable to open fire ect upon a bracket, the short limit of which is based upon servation of a single round, fire should be first delivered

throughout the observed bracket. Observation of effect fro
fire at the short limit of the bracket indicates that the bracke
is appropriate; if such effect is not observed, a range 100 yard
short of the short limit must be included in the fire for effect.

1361. In general, the seeking of a 200-yard bracket, o
greater, indicates that fire for effect should be opened as soo
as one observation at each limit has been obtained.

1362. When the short limit of a 200-yard or greater bracke
is based upon the observation of two or more rounds, a rang
short of the near limit is rarely necessary.

1363. Whatever the number of observations, it is not nece
sary to fire for effect with shrapnel to include ranges beyon
the observed long limit. If the number of observed overs is tw
the long limit may be included; and if the overs are less tha
two, the long limit should be included, unless the bracket is a
small as 100 yards or less.

**1364. The searching of areas is never to be resorted to unles
it can be definitely determined that the enemy is actually locate
within the area selected, and unless he would evidently exercis
a material influence upon the progress of the combat if lef
undisturbed by fire.**

1365. When time fire over friendly troops must cease wil
depend upon the range, the terrain, and the conditions o
observation.

In firing over friendly troops advancing to the assault, fir
at the target should cease upon a suitable signal from th
Infantry that the fire is dangerous. The range may be increased to hinder the bringing up of hostile supports or t
cause losses should the enemy fall back.

At medium ranges over level ground the danger space
Infantry from well-adjusted time fire extends for a distance

about 300 yards in front of the target. This distance becomes less if the ground rises toward the target, greater if it falls toward it.

Height of Burst.

1866. If the adjustment of the distribution and of the height of burst have not been completed, bold changes with a view of adjusting them should be made, the rate of fire for effect being reduced, if necessary, to permit this adjustment.

If doubt is occasioned by the fact that other batteries are firing at the same target, a salvo or volley with projectiles of type different from that in use by the other batteries will usually be recognizable.

1867. When the height is maintained between 2 and 4 mils, the effect varies but little. Outside of these limits the effect diminishes very rapidly. A constant error of 3 mils in estimation of height of burst is equivalent to the loss of several caissons.

1868. For effect, a height of burst which is somewhat low is superior to one which is somewhat high.

1869. In passing from fire for adjustment to fire for effect the corrector should be raised by 5 mils if during adjustment there have been three bursts below the target to one above and by 3 mils if the bursts below have been equal to those above the target. If only one round has burst below the target to three above, no change should be made in the corrector.

1870. During time fire for effect about one-fifth to one-ninth of the bursts should be on graze, and the greater the range the greater should be the proportion of graze bursts.

1871. If the area to be searched is not deep and the slope not great, a mean value of the site may be taken, and a corrector used which will give low bursts at the near limit of the area i the slope is away from the guns, and bursts slightly abov the normal if the slope is toward the guns. This method wil always be used if great rapidity is desired. For searching lon and steep slopes, however, it is better to use the site of th near limit of the area to be searched and vary the correcto from volley to volley or salvo to salvo, raising it if searching u the slope or lowering it if searching down the slope.

Distribution.

1372. Exact distribution facilitates observation of fire, increases probable effect, and indicates good fire discipline.

1373. In fire for demolition, all projectiles which are not exact in direction are lost.

In fire against personnel, considerable latitude may be allowed in the adjustment in direction.

1374. The fire of a battery is usually distributed over th front assigned it for attack.

When time fire is employed the following considerations ar to be borne in mind:

(a) If the front to be attacked does not much exceed 12 mil in width, it is sufficient to converge upon the center of thi front, as the dispersion of fire, when a considerable number o rounds is fired, will provide for covering the full front.

(b) Fronts which do not much exceed 35 mils may be covered effectively by a battery without sweeping.

(c) If the front much exceeds 35 mils, it may be divided int sections and each section attacked in turn, or sweeping may b employed. The choice depends upon the nature of the targe and the circumstances of the case.

1875. In shrapnel time fire the right piece is directed not upon the right edge of the target but upon a point about 10 yards inside of the right edge. To direct the left gun upon a corresponding point inside the left edge, the devisor of the front of the target is the number of guns firing, not that number decreased by one (1190).

1876. Knowing the width of his target in mils, the battery commander quickly decides whether to employ converging fire, fire without sweeping, or fire with sweeping.

In the latter two cases he secures distribution by directing each gun upon one-fourth of the front to be attacked.

If direct laying is to be employed, he indicates clearly to the chiefs of section the outer limits of the target, if these limits are not in themselves obvious; and each chief of section points out to his gunner the part of the target on which his gun is to be initially laid.

If indirect laying is to be employed, a distribution difference equal to one-fourth of the front in mils is used.

1877. When the mean height of burst of shrapnel is well adjusted, each gun is expected to cover effectively a front of 20 yards if one round is fired, 25 if two are fired.

The construction of the carriage permits a traverse of about 70 mils on either side of the axial line.

As sweeping fire is especially adapted for use in cases when the fire has been carefully prepared upon definite hostile positions, time may be afforded for giving the initial direction with the gun set at the extreme right traverse, if necessary. The full traverse on the carriage may thus be utilized; but it is not contemplated that a single gun will be given such a width of front to attack as to make this necessary.

1878. One turn of the traversing handwheel shifts the point of burst approximately 8 mils.

Therefore, in sweeping fire the front in mils covered by each piece will be equal to eight times the number of rounds in the sweep; the front in yards covered will depend upon the range.

The number of rounds to be fired in the sweep by turns of the handwheel is determined by dividing by 8 the number of mils in the front assigned to each gun to attack. If the quotient obtained is not exact, but consists of a whole number and a large fraction, then the next higher whole number is taken.

At 2,500 yards range well-adjusted sweeping fire will cover the front assigned completely. At longer ranges the front will not be completely covered, while at shorter ranges the sheaves of successive rounds will overlap.

For the attack of a large front two methods are applicable: (1) To divide the front up into equal parts and attack these parts in turn; (2) to form the sheaf at the outset so that it will cover the whole front and fire a sufficient number of rounds sweeping to cover the entire front.

If volley fire is to be used, the circumstances must decide which method is preferable. If time is not afforded for deliberate preparation, the first method is usually preferable; but if time is thus afforded, then the second method may often be found advantageous.

If the target is very oblique, different ranges may be assigned the different guns.

1379. Sweeping by turns of the handwheel is wasteful of ammunition when there is lost motion in the traversing mechanism, and should not then be attempted.

1380. Sweeping is preferably accomplished by the use of sights whose reticules have horizontal scales. Such scales are graduated in divisions of 5 mils, not numbered. At ranges up to 2,500 yards the line of sight is shifted 10 mils to the left after each round; above 2,500 yards each shift is by 5 mils.

The number of rounds required by this method is determined as for the other (1878), using as a divisor 10 or 5, as the case may be, instead of 8.

1881. Not more than four rounds should ordinarily be fired in in any one volley sweeping.

1882. When percussion fire is employed, the nature of the target determines whether converging or distributed fire is to be employed.

If the target to be attacked has a continuous front, e. g., walls, obstacles, etc., this front may be divided up into sections of 10 mils each and the sections attacked in turn, each gun taking its proportionate part. If the target has a much smaller front than 10 mils, the fire may be converged upon its center. If the target consists of artillery, each gun may be assigned a corresponding gun, depending upon the amount of artillery available.

Method of Fire.

1883. The rapidity with which fire for effect should be conducted depends principally upon the tactical situation. After adjustment has been obtained the volume of fire may be increased by increasing the number of pieces or by firing in more rapid succession than is practicable during fire for adjustment or by increasing the number of rounds in each volley.

Rapidity of fire must never be so great as to prevent fuzes being exactly set and the guns accurately laid, or otherwise to interfere with the work of the gun squads.

Deliberate fire is more accurate than a more rapid fire.

Great rapidity of fire is permissible only for a short time. The expenditure of ammunition is otherwise too great.

1884. The rapidity of fire of independent guns or platoons may be increased as much as possible to deceive the enemy regarding the number of guns in action. At times it may be advantageous to repeat the same range several times so as to give the impression that volley fire is being used by one or more batteries.

1385. Fire by salvos or volleys at successive ranges permits the captain to adapt the corrector to the slopes of the terrain.

1386. Volley fire is adapted especially to the attack of fugitive targets that are more or less vulnerable. The special characteristic of this method of fire is its great flexibility and rapidity. The number of volleys to be fired, their range difference, the number of rounds in each volley, are all in the hands of the officer conducting the fire. By suitable manipulation of the sheaf he may readily shift the fire from point to point of the terrain, as necessity may require, and by adapting the bursts of fire to meet the crises of the action he may utilize the ammunition to the best advantage.

1387. While salvos are adapted especially to securing the adjustment of fire, they may also be used for producing effect especially with the idea of obtaining at the same time additional information on which to base a closer adjustment of the fire They are employed according to the principles of volley fire.

1388. Fire at will is employed solely for the close defense of the guns.

Against a slowly moving enemy, such as infantry, the fire should be commenced when he has arrived within about 350 yards of the gun; against a rapidly moving enemy, such as cavalry, when he has arrived within about 800 yards; the purpose in both cases being surely to establish a fire-swept zone through which the enemy must pass in order to reach the guns.

1389. Against Infantry in position and more or less protect by entrenchments the intensity of the fire should be regulat to suit the necessities of the case, as our Infantry advances the attack, being slow or ceasing entirely while the enemy is concealed or inactive, rising to great intensity when the crises of the action develop and the enemy exposes himself to meet them. Salvos may be used for the ordinary phases of the action, volleys for the crises, the object being to assist our own Infantry by inflicting as much damage as possible upon the enemy; by destroying his morale; by forcing him to keep under cover; and by preventing effective fire upon his part.

1890. Against Artillery in position, the first object is to gain the ascendancy over it by inflicting as much damage as possible upon the personnel. Immediately effective fire is particularly demanded if the enemy can be attacked at a disadvantage, as, for example, while limbering or unlimbering. Obtaining a bracket as small as the conditions justify, searching the depth of the bracket, carefully observing the fire, and securing as promptly as possible an accurate adjustment are the means to be ordinarily employed in attacking the personnel.

Due to the difficulty, however, of reaching effectively the personnel of batteries provided with shields and posted in masked positions, the struggle between evenly matched artilleries will often be long drawn out. If the enemy's artillery is temporarily overmatched, it may suspend its fire and shelter its personnel; but it must be expected to renew the struggle as soon as the pressure upon it is relieved. The aim must be to gain the superiority of fire by suitable concentrations of effect on the part of our own Artillery; the opportunity may then be gained to destroy the enemy's matériel by well-adjusted shell fire.

1891. A slowly moving target, such as Infantry, or mounted troops impeded in their march, may be quickly bracketed by salvos and then attacked by searching fire.

Infantry in march formation may be thus attacked, but immediate deployment on their part is to be anticipated, and the officer conducting the fire should be prepared to reach them probably behind cover, with a well-distributed fire.

Infantry moving to attack in deployed lines, a succession o thin lines, or in line of small columns may be met by volley successively reduced in range as the infantry approaches. I their formation is in line of small columns, the fire should b distributed so that a piece or platoon may bear upon each of th columns.

At close ranges infantry will probably endeavor to advanc by successive rushes from cover to cover. Such rushes may b met by volleys previously prepared for upon selected positions evidently in the immediate path of the enemy. If the position occupied by important bodies of the enemy during the interval of advance are well defined, accurately adjusted fire may b brought to bear upon such positions, and the ground betwee successive positions may be covered by searching fire when important movements of the enemy from one position to anothe are attempted.

1392. In the case of a rapidly approaching or withdrawin target, fire should be adjusted upon the target itself if practicable. A bracket of 600 yards will ordinarily be quickly obtained and volley fire at successive ranges will be opened. Th initial range for effect should be one toward which the target i moving, an ample allowance being made for the motion of th target.

A target having once been brought under effective fire, it subsequent movements may be followed by volleys varying i range and direction, according to the rate and direction o march of the target.

If adjustment upon the target is impracticable, some point o area may be selected which the target is expected to pass. I this case a broad bracket of the point or area is determined and fire for effect is opened when the target enters it.

1893. The application of the methods of fire previously explained should be practiced by the solution of theoretical and practical problems. The variety of such problems is so great that examples of their solution can not be given to cover all possible cases.

SECTION XIII.—UNITS IN OBSERVATION.

1894. In preparation for definite and imminent phases of an action certain bodies of Artillery may be ordered to observe the enemy in designated portions of the terrain and be ready to bring him under immediately effective fire.

If possible, the position of the enemy is clearly pointed out; but if his exact position within a certain area has not been determined, the area may be divided into sectors and a sector assigned to each important group of Artillery. In the former case the firing data are determined for the known position of the enemy; in the latter case, for prominent features of the terrain within the sector assigned.

With a view of being prepared for instant action, the guns may be laid upon the target or upon some selected feature of the terrain and the sheaf formed so as to provide for the desired distribution.

1895. Trenches should be dug for the trails wide enough to permit them to be shifted through the probable arc of fire.

The safe arc of fire may be taken as 45° on either side of the normal to the battery front, the presumption being that the guns are well aligned. In all cases, however, it is the duty of the chiefs of section to see that their pieces are not fired when pointed at a dangerous angle with respect to other pieces.

Earthworks can only be damaged. The fire directed
should be destined only for the defenders who are shel
them; percussion shrapnel or high-explosive shell will

Localities.

1400. Localities are attacked with a view of inflictin
on the troops that are believed to be assembled ther
render them untenable by the demolition of buildings, t
incendiary effect may sometimes be added.

They are attacked by the percussion fire of high-e
projectiles or by low bursting time shrapnel.

While light-artillery shell permits the accomplishmen
result sought, the shell of heavy artillery containing n
plosive can produce a greater disorganization of high
tial buildings and of compact groups.

Woods.

1401. If the borders are occupied, woods are attack
time fire.

When it is desired to reach troops concealed in the
of a wood they are attacked with percussion fire.

Reconnaissance and Staff Parties.

1402. These are very important targets, vulnerable,
nishing only fleeting opportunities.

Time fire is executed over a wide front, with a long
and maximum rapidity.

If, in order to assist our own Infantry, the Artillery is called upon to repress the activity of a long line of hostile Infantry in position, each battery may be required to act over a wide front. Good judgment and great versatility in the employment of fire are called for under such circumstances, in order that the desired results may be obtained without undue expenditure of ammunition in the earlier phases of the attack. Means may be employed to keep the entire hostile line under the menace of fire, single guns being freely used to repress special activity of the enemy in the sections assigned to such guns.

SECTION XIV.—TARGETS.

1898. Targets usually belong to one of the following classes:

(*a*) Obstacles, intrenchments.
(*b*) Localities.
(*c*) Woods.
(*d*) Reconnaissance and staff parties.
(*e*) Observers, signalmen, telephonists.
(*f*) Cavalry.
(*g*) Artillery.
(*h*) Infantry.
(*i*) Machine-gun groups.
(*j*) Aerial targets.

Obstacles—Intrenchments.

1899. Many obstacles may be destroyed by light artillery, but always at the price of a large expenditure of ammunition; they are attacked by high-explosive shell or percussion shrapnel.

Defenders behind stone walls may best be reached by demolition of the walls.

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Localities.

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Time fire is executed over a wide front, with a long br and maximum rapidity.

Personnel of Command, Observers, Signalmen, Telephonists.

1403. These are important targets of variable vulnerability. They present a certain fixedness. The front covered is narrow, and the bracket is reduced more and more. Time fire is used, followed by percussion fire if the target is on an observing ladder.

Cavalry.

1404. Cavalry is very vulnerable at a halt and when in close formations. It protects itself against artillery fire through its mobility and dispersion.

If the cohesion of the hostile cavalry is destroyed, and its dispersion is compelled, the results may be considered as serious to it and advantageous to the friendly cavalry. If it suffers some losses in both men and horses and is put in fear of crossing certain areas, the results will generally be the maximum that artillery may hope to secure.

To this end, time or percussion fire is used, and all measures are taken to increase the rapidity of fire. If the firing unit is not placed so as to have a direct view of the target, the sheaf is opened and fire over a deep bracket is commenced when the cavalry enters the area under observation. If direct laying can be used the target is followed by all the pieces, a wide bracket is sought and then searched by volley fire, commencing at the limit which the target is approaching.

The opportunity of firing on cavalry will be fugitive; the fire of short duration. The maximum rapidity of fire is essential whether by time or percussion. When cavalry directs its attack against a battery, the battery will act advantageously in establishing a barrier by percussion or time fire in front of the enemy's line.

Artillery.

1405. Artillery presents targets widely varying in vulne ability.

The greatest vulnerability exists from the commencement the reconnaissance until the occupation of the hostile position accomplished; that is, up to the moment that the enem artillery is ready to fire.

Effective fire on reconnaissance parties may cause importa delays in the occupation of position by a battery, and may d prive that artillery of its commander or embarrass communic tion.

Effective fire at the moment of occupation of position by battery may produce losses and such disorder that it will on recover with difficulty. Its retirement from under fire is al a most critical moment, especially when the retirement is ma by an entire unit.

If the firing unit is in position and the hostile pieces are se at effective range, a great consumption of projectiles will not needed to destroy its matériel. The number of projectiles r quired to hit one of the carriages of a section varies with t range and the conditions of observation. The average is abo 15 or 30, according as the target is at 2,500 or 3,500 yards rang Besides, fire for the demolition of matériel is effective agai the personnel.

If the pieces are not seen, if they are at a distant rang if the direction of the objective is known by its flashes onl or by the dust raised by its fire, fire for demolition can not employed without risking the expenditure of an unwarrant number of projectiles; but such artillery has nevertheless certain vulnerability to time fire. There are always observe who are incompletely sheltered and who are less so, generall when the artillery is firing. Furthermore, the shields will not confer absolute protection on all who are sheltered by them. The effect obtainable from time fire is increased when the batteries against which it is directed are under an oblique fire. Finally, impact burts may reach the cannoneers whatever may be their position.

A sufficient recession from the covering crest or from the mask renders an objective absolutely immune; for it is impossible to attack an indefinite depth of terrain. On the other hand, the greater the distance from the mask which the enemy is forced to take the more difficult become hostile communication and command. It is advisable to form an opinion, from all indications observable, as to the depth of the zone that may reasonably be supposed to contain the target. In certain cases this will be definitely known, in others simply estimated. The conclusion will indicate the expenditure of ammunition that may be required to produce a probable effect. The urgency of producing the probable effect will govern the decision.

1406. The varying conditions indicate the following principles governing conduct of fire against an artillery target.

If priority in occupation of position is obtained, careful observation is made of indications of the enemy's reconnaissance and occupation of positions. At the moment of these operations time fire is opened through a large bracket, over a broad front, at maximum rapidity. This will be repeated, if necessary, the adjustment being refined.

If priority of occupation is not obtained, or if the opportunity of firing at the moment of hostile reconnaissance and occupation of position has been allowed to pass, a different procedure is advisable.

When the pieces of the hostile artillery are visible, time fire should be used at first to reach the uncovered personnel and to produce a demoralizing effect. This effect is then extended to the personnel under cover by the use of time fire, the limits of the bracket being reduced as much as possible, and the front covered being limited to the actual front of the target. The effort is continued to destroy the personnel, and then the demolition of the matériel by percussion fire is attempted. Fire is delivered on all visible pieces as accurately as possible and continued until the results sought are obtained, unless another attack should demand the attention of the battery, or unless the scarcity of ammunition demands the exercise of economy in that respect, or unless the range is so great as to prevent the carrying out of fire for demolition. In such a case a subunit of the battery may remain ready to fire should the target again manifest activity.

When the hostile pieces are not visible their presence may be disclosed by the flashes, by the dust raised by fire, or by other indications. The method of attacking them is similar to that just described, except that study of maps and terrain must be made to establish the far limit of the bracket, the near limit being the covering mask, and that fire for demolition can not be usually undertaken. If it proves impossible to reduce the limits of such a bracket, and should there be uncertainty as to the effect produced on the target, it is advisable to await the appearance of new indications. These should be most carefully observed in order to take advantage of any opportunity that may be offered. The firing unit remains in observation of the target, and a minute search is made for its observers or its battery commander's station. If these are discovered, efforts should be made to destroy them.

1407. Fire for demolition requires great accuracy in range and direction, thereby necessitating careful observation of each round from each piece. Its employment is permissible only [illegible] the nature of the target indicates that fire for demolition [illegible] be carried out and when the number of batteries at hand is such as to limit the front to be attacked to about 100 yards per battery. If the target is such that fire for demolition is not admissible, one battery will give a sufficient volume of time shrapnel fire against an artillery target, however dense it may be, provided the front does not exceed 200 yards.

Infantry.

1408. Infantry, like artillery, offers targets of variable vulnerability. But while the artillery of the enemy once in place constitutes a definite target, whose only important modifications are that it may pass from action to inaction, sheltering or exposing more or less of the personnel, the infantry target changes form, dimensions, density, and sometimes position from one instance to another. An artillery target may sometimes be destroyed; it is practically impossible to destroy a body of infantry whose elements avoid fire individually and may sustain fire almost without loss.

Finally, it may be said that artillery is proportionally small in quantity, and that by reason of the power of even a single piece, each unit or subunit which is seen or is firing is of sufficient importance to be attacked, while the Infantry exists in very large numbers, is almost everywhere, but is in fractions of small importance. Because of their weakness these small fractions do not attract fire, or by their multiplicity oblige those who wish to fire against them to disperse their fire. Fire against infantry targets will often fail to produce great losses, but other results may be expected.

On the defensive, the assailant may be obliged to deploy at a distance, to scatter his units, to seek defiladed routes, to hesitate to traverse the fire-swept zones or to traverse them only at serious loss. Later our own Infantry by stopping the enemy will transform him into a fixed target of considerable density and vulnerability.

On the offensive, the defender may be held to his cover, prevented from firing when it is to his interest to do so, deprived of the use of certain points of support, and restrained in the effective use of his supports and reserves.

1409. Generally such results will be obtained by firing a few projectiles at a time, using the proper method of fire, as often as opportunities offer, taking into consideration the amount of ammunition on hand, the rapidity of progress of the general action, and the approach of the assault.

As the crisis approaches, the Infantry will become more and more numerous until the height of the combat is reached. In order not to develop uselessly all the Artillery and to have all the Artillery ready to resist surprises, it will be advantageous, so long as the situation is not fully developed, to engage against the Infantry and Artillery only the necessary number of guns. By the use of suitable units and methods of fire, and by firing first on one part then on another part of the front assigned him, a captain may effectively attack Infantry operating on a front of from 300 to 600 yards.

Due to the great variety of cases which may arise, only the most general instructions can be laid down for the conduct of fire against Infantry. The best guaranty of well-conducted fire is to be found in the ability of the captain. He should have self-reliance, good judgment, keen tactical sense, quick decision, thorough knowledge of the capabilities of the matériel and great experience in command.

Machine Guns.

1410. Machine-gun groups have much the nature of Infantry attacking, but they are of greater importance than small fractions of Infantry on account of their great volume of fire. If they are discovered to be firing, they should be attacked with time fire over a broad front and a deep bracket. Under the best conditions of observation from a station near the guns the bracket can not usually be reduced below 200 yards. Owing to the ability of the personnel to disperse and to seek cover, the fire must be rapid. Once forced to cease firing, the area containing the machine guns should be kept under close observation, with a view of preventing resumption of their service or their withdrawal for use elsewhere.

Aerial Targets.

1411. Fire against targets in the air generally requires the assignment of particular units to the purpose, the digging of circular trenches about 36 inches deep for the trails to permit the use of high angles of elevation, the provision, if practicable, of platforms for the carriages, and the organization of a system of lateral observation with means of sure communication between observers and battery commander's station.

1412. Captive balloons are very vulnerable within the limits of the trajectory and the action of the fuzes. They have slight motion within narrow limits, and are attacked by direct laying with time shrapnel. It is indispensable that the rounds be correct for deflection. Ranging is commenced, unless the range can be measured, at the long limit of the fuze to ascertain whether the balloon is within time-fire distance, and the bracket is obtained and fire for effect conducted by the usual methods, except that for effect the burst height should be greater than normal to insure wide dispersion in the shrapnel cone. W range finder is used, a bracket may be assumed on the l is the first observations for range.

Dirigibles and aeroplanes are vulnerable. Direct laying used with time shrapnel. Each platoon is fired separately, beginning at the far limit, the other at the short limit, of estimated bracket as wide as 2,000 or 3,000 yards. Each fi volleys of one or two rounds at ranges differing by 200 yar the successive ranges approaching the center of the brack When the bracket has been covered or when lateral obser tions indicate that the target is out of the bracket the process repeated.

If the range finder is used, a narrower bracket may be tempted.

As aircraft may readily change their direction, height, speed, deflection, and corrector changes will usually be neces during firing. Essentials of success are rapidity and accur in service of the piece, skillful operation of the range find and, on the part of the officers conducting the fire, quick decis and command and boldness in changing ranges without delay

Targets with Respect to Terrain.

1418. Targets may also be considered with respect to nature of the terrain on which they are situated.

An enemy entering the dead space existing in front of a b tery can not be attacked by ordinary means. Some effect m be obtained by causing the projectile to burst on the traject which corresponds to the minimum range. This may be d by raising the corrector by 5 points at a time. If the correc scale is not sufficient, it may be left constant, and the expedi may be used of increasing the site by successive increments o mils each and by decreasing the range 200 yards for each increment of 5 mils. This decreases the range to point of burst by an amount roughly corresponding to an equal change of the corrector. This kind of fire is appreciably effective only within very narrow limits.

The effect is always inferior to that obtainable with the true trajectory of the target and is dependent upon the minimum ranges and the profile of the terrain below the trajectory. On a horizontal terrain with site 0, range 2,000, the effect may be considerable, even when the target is under the highest part of the trajectory. If the range is greater than 2,000 yards and the burst center is raised, the effect decreases rapidly and ceases to be appreciable when the target has penetrated the dead space a very short distance.

If the terrain falls off abruptly beyond the mask, the minimum range at which effect may be obtained by the above methods rapidly decreases.

1414. A target scattered over a glacis sloping down toward the battery can not be equally affected by time fire in all its parts unless the points of burst are kept at a constant and effective height above the terrain. This may be realized by simultaneous changes of the range and corrector in the same sense. The relation between the variations of the two elements is not constant, but depends on the inclination of the glacis, and may be best controlled by careful observation of the proportion of bursts obtained on graze.

The case is similar if it is attempted to follow a target up or down such a slope.

Difficulties may usually be avoided without great loss of effectiveness by adjusting the corrector on a point at midheight of the slope and using it unchanged until the site has been considerably altered.

1415. A target marked by a crest may always be attac though it had considerable depth. To overcome the effect slope of the terrain increases of range must be accomp by lowering of the corrector. The steeper the slope the l the range be changed and the more the corrector.

For example, if the terrain has a slope of 60 mils, incr the range setting by 50 yards and lowering the correct 2 mils will increase the burst range by about 100 yards; slope is 90 mils, a range increase of 25 yards and a co diminution of 3 mils will cause a change of about 100 ya burst range. The height of burst above the point of i will not be materially changed in either case.

If percussion fire is used, range changes to correspond yard bounds on flat terrain must be less than 100 yar amount depending upon the steepness of the slope. greater than the angle of fall can not be struck by perc fire.

1416. Percussion fire of shrapnel may be very effective a animate objects beyond a crest on slopes giving bursts o chet. At 3,000 yards ricochet may be expected from slo 50 mils or more. The slope most favorable for effect is about 115 mils. However, both ricochets and effect are influenced by the character of the soil. When effect b fire can be obtained it is possible to avoid complicated c of corrector to overcome the influence of slopes.

1417. Against a target whose elements are at the same but in different planes of site the site is varied among the

Against a target whose elements are in the same plane but at different ranges the elevations of the pieces m varied correspondingly. But this must be regarded as tional, a suitable method of attack being by successive v with less than the usual range changes, throughout the bracket inclosing the whole target.

SECTION XV.—FIRING IN THE BATTALION.

1418. The duties of the battalion commander are mainly tactical.

He informs the battery commanders as to the tactical situation, the mission of the battalion, and the rôle of each battery. The more detailed this information the more surely may the major rely upon correct initiative by his captains when communication fails.

1419. The rôle assigned to a battery should be given broadly, leaving to the captain within his sphere a full power of initiative and fixing upon him a definite responsibility.

1420. The major should conserve his force by assigning to a particular task only so many of his units as should accomplish it with their maximum power. He may thus be able to retain at his disposal other units to meet contingencies not yet developed.

1421. In some cases, as when the major is far away from a battery commander's station, the designation of a target will be very difficult. The use of two or more easily identified reference points facilitates the designation of objectives. But it may be necessary for the major to calculate the firing data for his position and to transform it for use at the captain's station.

1422. It is certain that under fire communication will be interrupted or at least delayed. It may be renewed during lulls in the action. Rapid and effective communication requires that the major and his captains easily understand one another, and that common, concise expressions for identical thoughts be practiced. This becomes particularly necessary in order that the major may be replaced by one of the captains without causing a failure of fire direction.

It is likewise necessary that the personnel be imbued with a common doctrine of offense and defense and have a thorough knowledge of the conduct of fire appropriate to various targets.

Under such conditions only may the action of the battalion be expected to proceed with the greatest effectiveness and without demoralizing interference of higher commanders in the conduct of fire.

1423. During adjustment the battalion commander's duties will usually be limited at first to the correction of errors in identifying targets, and to the prevention of interference between the batteries. It will be impossible for him to follow the adjustment of more than one of his batteries.

As the action progresses he should form an opinion as to the effectiveness of the fire by particular batteries and upon particular targets. He must cause his captains to conform the rapidity and duration of their fire to the results that are desired. **If he finds it necessary to intervene in the conduct of fire, he thereby assumes personal responsibility for the results.**

In general, the major will devote his attention principally to the assignment of targets, to the observation and study of the terrain and of the situation; to the digestion of information received from higher commanders, friendly troops and auxiliary observers; to reports to the regimental commander regarding changes of the situation; to amplifying the information already furnished to his subordinates and to rendering them every possible assistance; to keeping open the lines of communication; to preparation for the effective use of unengaged batteries; to maintenance of the supply of ammunition.

1424. The simultaneous adjustment of two or more batteries upon a target or within a small area is very difficult. It is to be avoided by adjustment in turn, or by the assignment of particular adjusting points, when concentration of fire by several batteries becomes necessary. It is simplified by the transference of data from one battery to another and by the deliberate and accurate calculation of data.

Adjustment upon a target already under fire for effect is still more difficult. Either the unit firing should increase the volume of its fire sufficiently to accomplish the object desired or it should cease firing until the new unit has adjusted.

1425. Frequent changes of target materially reduce effect. Except in emergency, the mission of a battery at the moment should be completed before a new target is assigned.

The right of a battery commander on his own responsibility to change target to meet sudden changes in the situation, when communication has been interrupted or in the belief that the major can not be early enough informed, should not be abridged.

SECTION XVI.—NIGHT FIRING.

1426. If the target area is illuminated by searchlights, firing may be conducted against targets of all kinds the same as by daylight up to the effective range of the lights. It will often be necessary to fire as at instantaneous targets to take advantage of brief periods of illumination.

1427. If searchlights are attached to an Artillery unit, they should be established on high points well to the front and flanks, if possible. Telephonic communication should be established, so that the light beam may be directed and held upon the target. By using two searchlights the illumination may be intensified or the illuminated area increased in size, or one may be used to search for targets while the other directs its beam upon one already under observation.

In attacking searchlights the same methods are used as in attacking captive balloons.

1428. If searchlights are not available, preparation of fire should, if possible, be made before dark. Fire should be at different ranges, the number used depending upon the degree of accuracy reached in preparation of fire, and upon the depth of the area to be kept under fire.

1429. Preparation of fire will be most reliable if the battery, or at least part of the guns, can be placed in position before dark. If this is not possible, the necessary measurements and calculations must be made during daylight with the greatest possible accuracy.

1430. Range and corrector setting are best obtained by fire for adjustment during the day. If this is impracticable, the range must be determined from the map or from range-finder measurements. Heights of burst may be adjusted with sufficient accuracy at night, if the aiming circle or telescope can be set up and adjusted before dark.

1431. To permit of turning fire upon different targets or areas, direction is taken by daylight to a principal registration point, using the guns themselves or the aiming circle. The angular distances from this point to the various targets or target areas are then measured and recorded, and also the breadth of front of each. If guns have been placed in position. it is well to verify the directions by registration shots.

1432. These data will be entered on a sketch; each target or area will be designated by a letter, care being taken not to use letters of similar sound, and opposite each target will be noted the range, site, corrector setting, deflection from the registration point, and breadth of front.

Copies of this sketch will be made for all Artillery commanders concerned. Additional copies will be given to auxiliary observers, who will make their reports by reference to the sketch, using lantern signals or wire communications.

The position will be reconnoitered by daylight, and the line of the front and the positions of the guns marked, preferably by a white strip with short crosspieces.

If the preparations can not be made before dark, it is impracticable to fire at all, except at illuminated targets. For this purpose an auxiliary observer on a flank is necessary, with whose assistance a broad bracket is obtained, and fire for effect opened upon the bracket with ranges differing by 100 yards. Ranges should be eliminated or added, according to the reports of the auxiliary observer.

1488. For night firing, stakes carrying lanterns may be provided as aiming points. Similar stakes may be used by observers to fix the directions to targets. Sights must be illuminated.

CHAPTER VII.

TARGET PRACTICE.

1434. Target practice includes—

(*a*) Pistol practice.
(*b*) Subcaliber practice.
(*c*) Service practice.

Pistol Practice.

1435. Pistol practice will be conducted as prescribed for Field Artillery in the Small-Arms Firing Manual.

Subcaliber Practice.

1436. Subcaliber ammunition will be used for perfecting units in fire discipline and for practicing officers and men in all the mechanisms of fire. To attain these ends, practice will be held on terrain where the strike of the bullets can be plainly seen from the guns.

1437. By reducing dimensions of targets, intervals, distances, and ranges to one-tenth of those met in service, very realistic simulation of service conditions may often be obtained, and opportunity afforded for practice in using instruments and field glasses and in computing firing data under varied conditions.

Service Practice.

1438. Organizations will be prepared for service practice by careful and detailed preliminary instruction, during which the provisions of paragraphs 1 to 3 will be kept constantly in view. The preliminary training contemplates—

(*a*) The study of principles and methods.

(*b*) The training of organizations to a skillful and accurate performance of their duties.

(*c*) The application of this training to the solution in the field of problems simulating those met in war.

The successive steps to be followed in the training are: First, the establishment of thorough fire discipline in the unit by means of constant drill and subcaliber practice; second, exercises in the field, in which technical problems are assumed, making use of actual targets or of such natural features of the landscape as may be available; third, the solution of tactical problems of a character illustrating conditions of service in war.

1439. In order that all junior officers may receive the maximum instruction they will be required to command batteries at drills and in tactical exercises involving the reconnoissance, selection, and occupation of positions, the preparation of fire, and the departure from positions.

1440. At service practice all officers who are not required for the service of the unit actually firing or who are not detailed for specific duties connected with the practice will be assembled at some convenient point from which the fire may be observed, but where they will not interfere with the officers directing and conducting the fire. They will be informed regarding the situation and the targets, and will compute and record appropriate firing data. They will also record their observation of each round in range, height of burst and distribution, and their changes of data based thereon. These records will be taken to the subsequent critique and there discussed.

1441. No service practice will be held by any organization unless suitable and ample terrain for the conduct of the practice in conformity with the spirit of this order is available. If such terrain is not available, application will be made by the Artillery commander to superior authority with a view of securing suitable terrain on which to hold the practice.

1442. The final results obtained in service firing should be regarded as showing to what extent the organization concerned is prepared to perform its duties under battle conditions. Regimental, battalion, and battery commanders must keep this end in view during the period of preparatory training and also during the practice, and make every effort to derive the greatest possible advantage from the ammunition allotted to their respective organizations. This allowance will be expended in problems involving fire direction for field officers and conduct of fire for battery and Artillery staff officers.

1443. The senior Artillery officer present with an organization will allot firing problems as follows:

(*a*) To each officer commanding a battery at least three problems.

(*b*) To the other officers present with or assigned to the organization for practice as many problems as the remaining ammunition will permit and in such proportion to these officers as he may consider to be for the best interest of the service.

He will also fix the maximum amount of ammunition to be expended in each day's firing.

1444. Exercises for colonels and lieutenant colonels will include the preparation of problems, and where two battalions, real or represented, are available, the execution of problems in which they will reconnoiter and select positions for the battalions, establish communication with the battalion commanders and with an assumed higher commander, and arrange with the latter for the supply of ammunition. In the exercise of fire direction and supervision of fire they will issue such orders and instructions as will cause the batteries to fire on their proper targets in accordance with assumed varying phases of the problem.

Problems for majors, where they supervise and direct the fire, will be the same as for colonels. Where they direct the fire as battalion commanders under supervision of the regimental commander they will reconnoiter the position assigned the battalion, designate the position to be occupied by and assign the proper task to each battery, establish the required communications, assign a position to the battalion combat train, arrange for the supply of ammunition, establish auxiliary observers where necessary and practicable, establish the service of security where the situation requires it, and will, during the firing, send to the officer conducting the fire all available information to assist him in properly carrying out his problem.

Problems for captains and lieutenants will include the duties of the battery commander in reconnoissance and in conduct of fire on targets designated by higher commanders.

In several of the problems the officer supervising the practice will arrange to outline the troops which the Field Artillery is supporting, to represent the ammunition trains by men and material taken from organizations not participating in the problem, and to establish the required communications.

1445. In the course of each year's practice, all of the problems commonly met in war service should be illustrated. This can be accomplished only by a systematic and methodical advance preparation of a schedule of firing exercises for the command concerned. The progression should be from simple problems to the more difficult ones.

Each battery and battalion should have at least one exercise yearly involving fire from more than one position, preferably with different methods of laying; each battalion at least one exercise yearly involving the direction and conduct of fire of all its batteries simultaneously.

All problems of the same day should be based on a simple tactical situation.

1446. Complex problems should be distributed over a period of years.

1447. The amount of ammunition to be expended in each problem will depend upon the principles which it is intended to illustrate. Ordinarily the problem should proceed only through adjustment and such other firing as is necessary to test the conclusions reached by the officers conducting the fire. Each year, however, some practice in fire for effect by all the mechanisms of fire must also be conducted.

In the earlier problems allotted to officers the firing may be conducted very slowly, discussion before assembled officers following each phase of the problem, such as the determination of firing data, methods of fire to be used, observation of fire, sensing, changes of data, etc., before the next step in the problem is taken. As skill is attained increase of speed must be insisted upon.

Officers supervising or directing the fire should terminate a problem at any time when they consider that conduct of fire is inefficient or when the principles involved have been demonstrated.

1448. When material targets are used, their dimensions, appearance, and, except for moving targets, their resistance to effect should conform as closely as possible to the troops and material that they represent.

Material targets will be used for all direct laying and for all fire for effect. In problems intended to be carried only through adjustment of fire, targets may be merely assumed to exist.

All targets are disposed in accordance with a tactical situation.

1449. Ammunition chests will be packed as for active service as far as the ammunition on hand permits.

1450. The senior Field Artillery officer will preside at critiques of each day's firing.

1451. Practice by battery will be supervised by battalion commanders and by regimental commanders; by battalion, by regimental commanders; by regiment, by brigade commanders or the senior Field Artillery officer; by larger units and in the arms combined, by higher commanders.

1452. In the execution of problems, particularly during the firing, losses of officers, men, and animals, injuries to matériel, and the necessity for ammunition resupply will be simulated from time to time.

1453. The officer supervising the practice—

(*a*) Will prepare in writing problems to be solved by the officer directing the fire. The problems should involve the use of the artillery units in as many of the different rôles to which they might be assigned in service as the allowance of ammunition will permit.

(*b*) Will provide a range officer and a range guard detailed from the artillery command, and preferably from units other than the ones taking part in the problems; will furnish the range officer with a copy of the problem, inform him as to the kind and location of the targets required or that will be assumed, and in a general way indicate the position of the observing station for the range party.

(*c*) Will provide assistant range officers, a safety officer, and a timekeeper, and inform them in sufficient time as to the approximate position to be occupied by the battery whose fire they are to observe.

(*d*) Will inform the officer directing the fire, when other than himself, as to the time and place at which to report with his unit to receive the problem.

(*e*) Will, when more than one battery takes part, so the execution of the problem that the fire of each bat be observed and recorded separately, except in simult firing.

(*f*) Will, immediately after each fire problem or after practice, conduct a general critique of the firing, pointing errors of methods, observation, and judgment, and giving a sion as to the conduct of the problem, conferring with the r observers if communication with them is established.

(*g*) Will, as soon as practicable after each day's prac conduct a detailed critique of each problem fired, based on various reports required. This critique will cover all the ciples illustrated by maneuver or fire during the problems. will include comments on such subjects as:

Condition of matériel and adjustment of sights and ments.

Use of headquarters detachments and battery comman details.

Marking the route.

Reconnaissance of targets and position.

Selection of position.

Decision based on the tactical situation.

The service of security.

Assignment of units to particular tasks.

Communications.

Clearness and brevity of instructions given.

Designation of objectives.

Reconnaissance by battery commanders.

March discipline.

Occupation of positions.

The preparation and use of cover.

Posting of combat train and limbers

Suitability of methods of fire.

Fire discipline.

Time consumed in—

1. Reconnaissance and selection of position.
2. Assignment of units to positions.
3. Occupation by each unit of its position.
4. Designation and identification of targets.
5. Opening fire.
6. Fire for adjustment.
7. Fire for effect.

Effect obtained.

Replenishment of ammunition.

Advance or withdrawal from position.

Accuracy and completeness of records.

Free discussion will be encouraged during this critique in order that all may profit from the mistakes made as well as by the correct methods employed.

The officer conducting the critique will express a definite opinion as to merits of the various features of the problems and as to the time consumed.

1454. Critiques should be short, good-tempered, impersonal, interesting, lively, and instructive.

Contention and hair-splitting discussion of far-fetched and petty points are exasperating and tiresome and therefore harmful.

Events are discussed in the order of their occurrence.

That conducted after each problem is general in terms and covers briefly the incidents of firing only while impressions are still fresh in the mind. It clears the way for the subsequent detailed critiques, which need not again touch upon the points disposed of except in the direction of such elaboration and correction as are made necessary by the practice reports. At the latter critique each commander who has had to do with a phase of the problem should give a brief sketch of his execution of the orders received, followed by a frank statement of the errors made of which he is conscious. The officer conducting the critique will then clear up any doubtful circumstances by appropriate questions and will discuss the important features of the problem. Criticism must be well-founded and just. Violations of principles laid down in these regulations must be considered faulty, but in differences of opinion as to the suitability to the situation of alternative authorized methods the comment must be explanatory and advisory.

1455. The officer directing the fire—

(*a*) Will, in general, be responsible for the tactical handling of the problem.

(*b*) Will make such arrangements as are necessary to have his unit at the proper time at the location designated by the officer supervising the practice for receiving the problem.

(*c*) May, if he considers it advisable, when the officer conducting the fire has reported the data he used in the simulated fire for effect, order verifying salvos or fire for effect if the allowance of ammunition for the problem is not thereby exceeded.

1456. The officer conducting the fire—

(*a*) Will, on receiving instructions from the oficer directing the fire, proceed with the solutions of the problem with the ammunition allotted.

(*b*) Will, when directed not to proceed beyond the adjustment of fire, order the fire to cease when adjustment suited to the situation has been obtained, and then execute a simulated fire for effect. If the officer directing the fire is not in a position to hear the commands for simulated fire, the conductor of fire will have them communicated to him at once.

1457. The range officer—

Will report for instructions to the officer supervising the practice and with his range party will prepare, place in positions indicated, and, when necessary, operate the targets prescribed. He will observe and report upon the firing and submit at the conclusion of the day's practice the prescribed reports.

For the purpose of securing safety of the range during firing, he is responsible—

(*a*) That the terrain in the line of fire is examined before firing commences, and that all people and live stock are excluded and kept therefrom.

(*b*) That guards are posted so as to cover all approaches to the sector of fire, which includes the terrain from the guns to the target as well as the danger zone beyond the target.

(*c*) That the guards are properly instructed as to their duties. This instruction he will give in person.

(*d*) That whenever the firing should be stopped on account of danger on the range, a red flag is displayed where the officer conducting the fire can see it.

(*e*) That when the range is clear a white flag is displayed.

1458. The assistant range officer No. 1—

(*a*) Will report to the officer supervising the fire for instructions.

(*b*) Will provide himself with the necessary instruments and blanks, and be, at the proper time, at the position of the battery whose fire he is to observe.

(*c*) Will inform himself as to the target assigned and observe from a position as near the battery as practicable and record the height of the burst above bottom of target in mils.

1459. The assistant range officer No. 2—

(*a*) Will report to the officer supervising the fire for instructions.

(*b*) Will provide himself with the necessary instruments and blanks, and be, at the proper time, at the position of the battery whose fire he is to observe.

(*c*) Will inform himself as to the target assigned and observe, record, and, in collaboration with the range officer, plot the distribution of shots with reference to the target and the line battery target.

1460. The safety officer—

Will report for instructions to the officer supervising the practice and will have the "red" flag raised and lowered as directed.

For the purpose of securing safety he is responsible—

(*a*) That no command is given for firing while the range, so far as visible to him, is not clear, nor unless white flag is displayed by the range officer.

(*b*) That before firing commences, and during its continuance, a "red" flag is displayed near the guns where it can be seen by the range officer.

(*c*) That the direction in which the pieces are laid does not endanger the range or observing parties.

1461. The timekeeper will record the times necessary to determine the data referred to in section (*g*), paragraph **1458.**

1462. All individuals in the military serivce who see that firing is about to take place which would be dangerous, will call out promptly "Cease firing" in a loud tone of voice, and if at a distance from the battery, make the prescribed signal therefor. The red flag in all cases indicates danger; the white flag that the range is clear.

1463. All persons not a part of the personnel of the unit firing except the officer supervising the practice and his assistants are forbidden to communicate with any of the personnel connected with the practice except to stop the firing in case of danger.

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